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THE MEASUREMENT OF ENVIRONIC FACTORS AND THEIR BIOLOGIC EFFECTS[1]

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THE simpler forms of plants in earlier geologic times lived in swamps and along seashores and under the equable conditions furnished did not attain anything beyond a primitive and elementary development. The chief bar to escape from the restricted moist habitats consisted in the fact that the life cycle of the plant included alternating generations in one of which, the sexual generation or gametophyte, reproduction was possible only in the presence of water. Finally, however, the spore which gave rise to this sexual generation began to germinate in place on the other generation and the resulting gametophyte was produced, and remained enclosed in the tissues of the sporophyte as it is among the seed-plants of the present day.

The domination of the sporophyte in this manner vastly increased the possibilities of evolutionary development, and when this plastic self-contained type of plant began to move out over the broad spaces of the world, all the ranges of temperature afforded by the earth's surface, as well as of moisture, illumination, concentration of the solutions in the soils, alkalinity, etc., were encountered to which to-day the manifold types of plants stand in a delicate adjustment.

Water was the chief determining factor when the vegetal organism was in a separated-generation stage, and it continued to be the most potent agency in evolution and differentiation as the new combined individual moved away from the swamps and shores to the occupation of the drier slopes of valleys and mountains and finally into the most arid of deserts.

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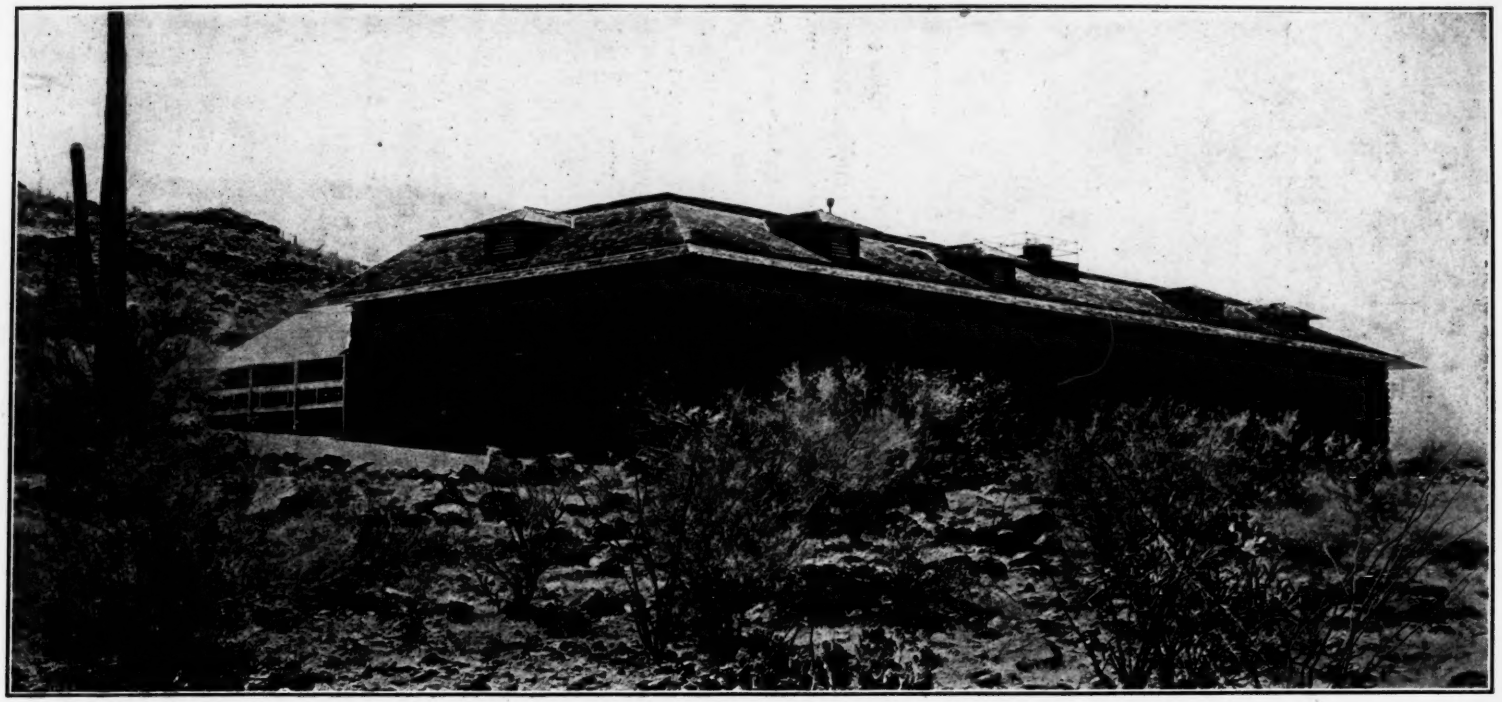


FIG. 1. THE DESERT LABORATORY, TUCSON, ARIZONA.

The relation of plants, and of all organisms to water, is, therefore, a fundamental one, and it is to the determination of these and other important environic relations that a large share of the attention of the department of botanical research is directed. If this conception has been properly formulated you will be prepared to receive without surprise the statement that the Desert Laboratory as the principal instrument of research of this department was not established primarily for the purpose of making studies upon desert vegetation as such.

There is no adequate foundation for a science devoted to the organisms which live in arid regions. There is no more a desert botanical science than there is a mountain astronomy. The physicist seeks and selects a place for the operation of his instruments in which observations and experiments may be carried on to the best advantage. The biologist takes one of his laboratories to the seashore and another to the desert, because here in these places organisms carry on the various processes in tissues of diverse structure and at different rates, and extended facilities for experimentation and widened angles of observation are made possible.

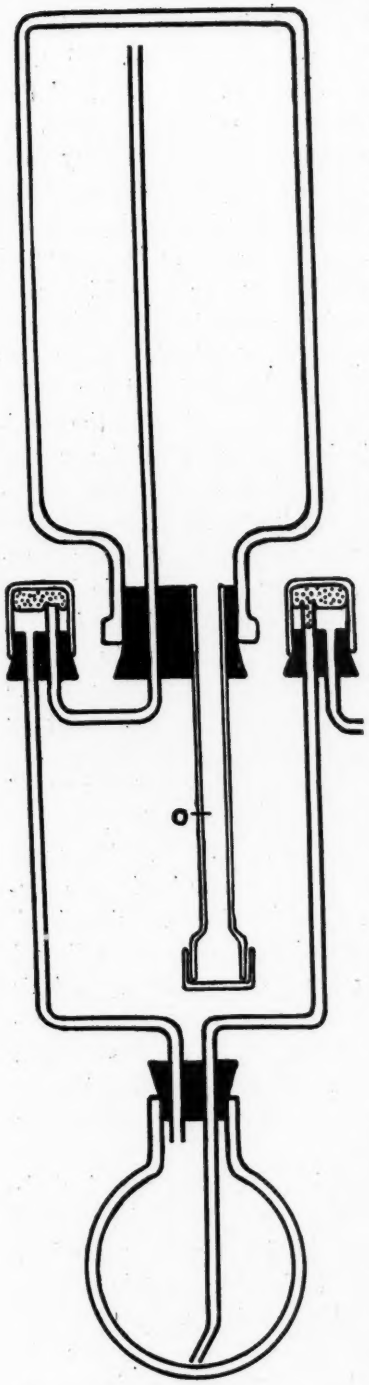
If to these statements as to the purpose and general scope of our researches, a few words be added as to the view-point taken as to the constitution of living matter itself, we may then profitably proceed to a discussion of the main thesis of the present paper.

Protoplasm is characterized by the fact that it includes an enormous number of compounds of carbon, oxygen and hydrogen, which sustain comparatively simple (chemical) structural relations to each other and most of which are highly unstable. These two features make possible variety and complexity in the mechanical structure and composition of the tissues of plants and animals, give opportunity for the occurrence of a multiplicity of chemical transformations in metabolism, and render all the functions of the organisms highly modifiable.

Any sense of daze we may experience from a contemplation of the number of things, or combinations in protoplasm, however, is not a logical excuse for going into the haze of vitalistic notions upon which much of the pedagogical practise and speculative writing in biological science of the present time is based. Ten, or ten million, the components of protoplasm act in accordance with a few fundamental physicochemical laws. Complexity of composition yields in importance to the types of energy transformations displayed, and to the external expression of what are known as the biological activities as they may be modified by the environment.

The plant may be profitably visualized as an upright cylinder of watery gelatine surrounded by a semi-permeable tubular casing. The lower extremity of this cylinder is ramified into roots which are in intimate contact with moist soil-particles, so that the water in the body of

FIG. 2. THE COASTAL LABORATORY, CARMEL, CALIFORNIA.



the plant is practically continuous with that in the substratum. The absorption of water by the plant, or rather the movement of water from the soil into the plant is influenced by the agencies which affect diffusion, osmosis and adsorption anywhere. In other words, the properties of protoplasm, as a mixture of colloids, cause water to move from the substratum into its body. The further movements of water, such as the ascent of sap, may be taken to result similarly from physical conditions. The uppermost part of the gelatinous mass of the plant ramifies as does the lower, but in this case into flattened organs or leaves. Here, as well as everywhere, on the external surfaces of the plant evaporation of water takes place in a manner modified by the specialized character and structure of the surface as well as by the relative humidity, temperature and movements of the air. This transpiration, or loss of water from the exposed surfaces, is a process of such importance that it is impossible for the plant to maintain growth to any extent, or carry out normal development without it. Consequently it has come in for a great deal of attention during the last century. Much of the work has been of a

FIG. 3. SECTIONAL DIAGRAM SHOWING THE ESSENTIALS OF THE SPHERICAL POROUS CUP ATMOMETER WITH NON-RAIN-ABSORBING DEVICE, AS FREQUENTLY ARRANGED. A rubber stopper in the bottom bears besides the supply tube to the first mercury valve, a larger tube for filling. The latter has a mask to serve as zero point and is covered by a loose-fitting cap. Suction through the open tube at extreme left removes the air from the system and fills the whole with water. Mercury in the valves is shown as if evaporation were in progress; when rain occurs the column rises in the right-hand valve and falls in the other.

qualitative character and most of the quantitative measurements have been meaningless, either by reason of the use of fragments of plants or because the calibrations were of a plausible rather than of an analytical character. As a matter of fact, this loss of water from the plant, like many organic activities, is complicated by indirect and accessory functions in such manner that the main processes are difficult to evaluate. It is desirable in all such cases to construct a physical analogue which will reproduce the essential feature of the process to be measured. Notable success in this case has been attained by Professor Livingston who has devised and perfected an evaporimeter consisting of a porous clay cylinder closed at one end, which is kept filled with water (see Fig. 3). The liquid saturates the walls of this vessel and evaporates after the manner in which it would in the plant, excepting for the modifications induced by light and by the incidental structural features of the plant. The exposure of the instrument during any given set of conditions for any period gives data from which the actual evaporation may be calculated. Comparison with measured areas of leaf-surface shows that departures from the normal evaporation are made by the plant, and the departure may be expressed as the *relative transpiration.* This relative transpiration is never more than seven tenths of the evaporation from the instrument, and is generally much less. The evaporimeter has given us a standard and means of measurement by which all of the phases of water-loss with reference to diverse environment, in widely separated localities, and in the different stages of development of the individual may be measured with exactness.

As was fully expected, the exact calibrations have yielded data upon which new conceptions have been erected and new generalizations formulated. Among these may be mentioned that of "incipient desiccation." When the water-loss from an evaporimeter and from a plant is followed throughout the course of a June day at the Desert Laboratory, it is found under certain conditions that the midday maximum of temperature is accompanied by a maximum loss of water from the instrument. When this was compared with the loss from a plant it was seen that in certain cases the increased loss of water from the latter toward the middle of the day was checked.

All other means of interpretation of this lessened water-loss, including a consideration of the partial closure of the stomata, as determined by Lloyd, failing to explain the fluctuation in the middle of the day, recourse was had to determining the amount of water actually present in the leaves at such times. This revealed a deficiency. Briefly put, water was being lost from the membranes of the plants faster than it was being supplied to them with the result that vaporization slackened. This condition was designated as *incipient desiccation* and, as it is not accompanied by any external indications, its discovery was taken to be of great importance, both scientifically and economically, since the

efficiency of the leaf as a food-forming organ decreases notably as the incipient drying stage is reached and long before externally visible, wilting or flagging is shown. The skilful agriculturist will, therefore, irrigate his crops not when they wilt but when the proportion of water in the leaves falls below a certain point.

Still another feature of relative transpiration and incipient drying remained to be detected and measured. Evaporation, of course, tends to render heat latent and hence keep down the temperature of leaves. Variations in transpiration should therefore be accompanied by characteristic temperatures. A calorimeter for the requisite measurements was designed by Mrs. E. B. Shreve. Leaves were put into a chamber filled with turpentine which penetrated the tissues quickly and realized the temperatures at once. The temperatures were found to meet expectancies, even in the stages of incipient desiccation, where the lessened water-loss was accompanied by the development of a degree of heat which might affect the efficiency of the leaf in food-formation.

Returning to the figure of the plant as a cylindrical mass of colloids, it is to be said that the water which enters the plant at its roots does not move as in a tube directly to the upper end where it is transpired. The cylinder may in effect be enlarged or variously developed to such shape that a surplus of water accumulates and if the supply be cut off from below the amount on hand may be such that the plant lives for a season, a decade or even longer upon the water on hand. I have carried out a series of measurements upon this phase of the water relations of plants during the last six years and find that many plants of arid regions in South America, North America and Africa show such accumulation of water. The sap of such plants under normal conditions shows about the concentration which gives an osmotic pressure of three to twelve atmospheres. When the supply is cut off the loss of water continues with the result that the concentration increases four or five times. The desiccation of these plants, however, is not simply that of drying out. The rate of loss decreases much more rapidly than would be justifiable on the facts of amount of water present, and one is led to infer that the plant again to be thought of as a cylinder of jelly undergoes changes of its colloids which tend to prevent transpiration. Whether such changes are reversible as in incipient desiccation or not is a matter yet to be determined. Without going into detail at all it may be said that the continued depletion of the store of water of a succulent is responsible for many important features in the life-cycle of the plant, in growth and reproduction and in survival (see Fig. 4).

The consideration of the facts brought to light in a study of the balances or accumulations of water in plants formed a basis for an analysis of the conditions of parasitism in the higher forms. This is primarily a water-relation. When one plant as, for example, the mistletoe, is parasitic on another, such conditions must be present as to cause water

to flow from the host to the tissues of the parasite carrying substances in solution. The experimentation in this subject consisted, first of all, in forming artificial parasitical relations between plants in order to ob-

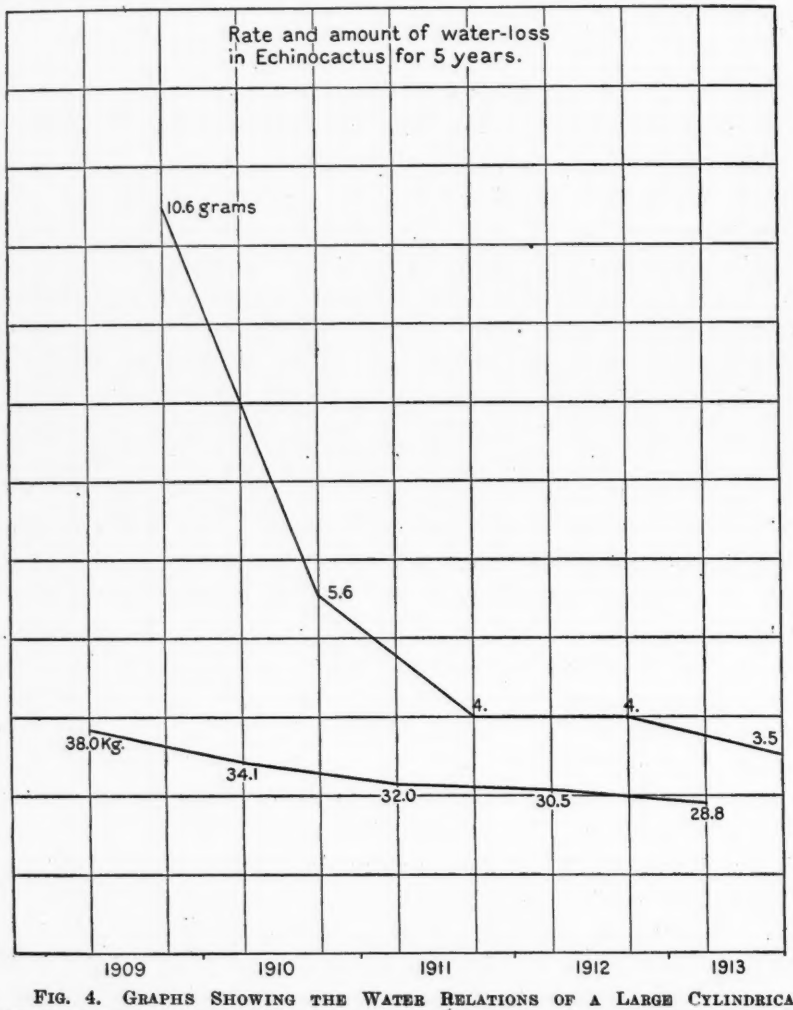


FIG. 4. GRAPHS SHOWING THE WATER RELATIONS OF A LARGE CYLINDRICAL CACTUS WHEN SEPARATED FROM A SOURCE OF SUPPLY FOR EXTENDED PERIODS. The lower line shows the weight decreasing from 38 kg. to 28.8 kg. in five years. The upper line shows the rate of daily loss which fell from 10.6 g. to 3.5 g. during this time. The rate of loss is not directly proportional to the succulence or amount of water present.

tain a number of couples which might be joined as host and dependent, and also equally important to find others which might not enter into this relation.

The succulents with their accumulations of water offered suitable material and, using these as artificial hosts a number of species were caused to live on them parasitically for months or even years. Having this material, analyses of the sap or watery solutions of the two plants

led, as might be expected, to the result that one plant which would live parasitically on another must have a more highly concentrated sap. Not all plants with a high concentration of sap may become parasitic on all those of low concentration, however, for other reasons, some of them seasonal, morphological, etc. (see Fig. 5).

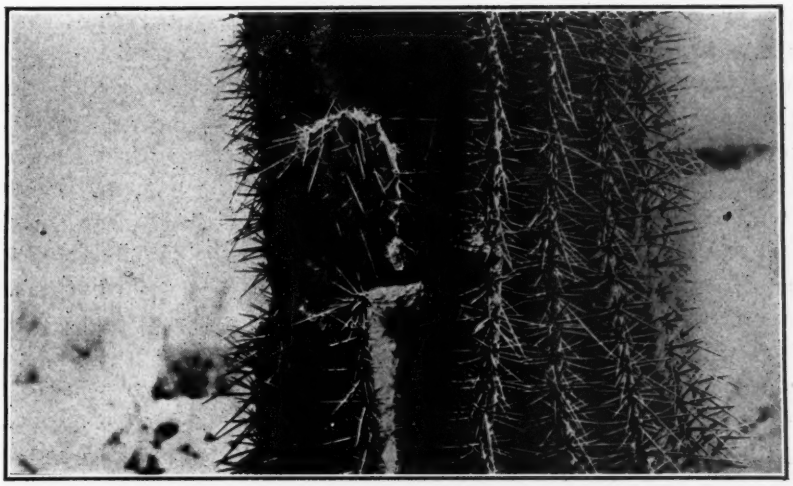


FIG. 5. A JOINT OF *Opuntia Blakeana* ROOTED PARASITICALLY IN A CAVITY IN THE BODY OF *Carnegiea gigantea*, under which condition it has existed for three years

The difficulties in dealing with the mechanical features presented by the soil are such that it has not yet been possible to construct an instrument which would give data analogous to absorption by roots as does the evaporimeter for transpiration by leaves. Developments in this matter are to be hoped for, however. Meanwhile the studies of Dr. Cannon on root-systems and the distribution of water in the soil have yielded some generalizations of no little value in the consideration of the aspects of the vegetation of a region. Among these it is to be mentioned that the treelessness of the immense stretches of western prairie and probably of steppes everywhere is a matter dependent upon the distance below the surface at which the so-called "ground water" or "water table" lies. Trees and forests may be established in such regions when the supply of moisture in the upper layers of the soil are increased by irrigation, conservation of rainfall or whatever artificial means may be employed.

Living matter is a thermal engine in which the energy of various substances is released very slowly by oxidation processes. It is also self-organizing and substances of various kinds entering into its solutions may be reduced and their components rearranged in the form of characteristic constituents and products and in turn become fuel for the engine. Many of these reducing processes are carried on in the presence

of light in the plant. Potassium and calcium nitrate, for example, yield nitrites and later ammonia in such a process, and acetic, glycollic, propionic, malic, tartaric and citric acid are broken up, yielding formaldehyde, carbon dioxide and other substances.

The greatest addition to the potential energy of the plant, however, is that in which carbon dioxide from the air enters leaves and in the ensuing process carbohydrates result and oxygen escapes. This photosynthesis is perhaps the most fundamental of all processes in the world of living things, since it is with this action initially that the construction of nearly all organic material is begun. Various theories have been proposed to account for the procedure from the entrance of carbon dioxide into the plant to the formation of sugars, but none of these will stand the test of our critical experiments. Their inadequacy may be ascribed to the fact that the function of the light in the matter is not yet clear. At present we may only say that upon the entrance of carbon dioxide into a leaf it probably unites with potassium to form the bicarbonate, in which salt it is more easily broken up than as if it remained a free acid. Here are then bicarbonate and water in the presence of chlorophyll, the green coloring substance of the plant. The spectrograph of this substance reveals the fact that rays of certain wave-lengths are absorbed by it. In other words, these rays impinging on the chlorophyll change the nature of its electronic movement and cause some disintegration of its structure. The disturbance, whatever it may be, is communicated to the bicarbonates, and to the water, which are reduced, the free oxygen escaping and some simple carbonhydrate resulting. So far we may proceed in complete harmony with known facts. Between this and the appearance of hexoses in the leaf is a wide gap. Once bridged and the full effect of light in the entire course of photosynthesis made out, it may be possible to simulate a process which now takes place only in living tissue, and make available to the race a source of energy all but limitless in its potentialities.

The formulation of plans for this work has necessitated a large number of measurements of intensity and of the reducing effect of light under various conditions and in various places in which experimentation might be carried on, by Dr. Spoehr. Among the noteworthy results of such calibration is the demonstration that the blue-violet rays, direct and skylight, is greater at the Desert Laboratory on a shoulder of the Tucson mountains (2,700 feet) sheltered from the prevailing winds and resultant dust, than on the summit of the Santa Catalina mountains (9,250 feet) in which the skylight is less, but the direct light passes through a layer of air a mile less in thickness than that which reaches the laboratory. Watery vapor and dust particles may account for some of the absorption of light on the summit of the forested mountain slopes.

Our concern with light as a factor of environment however by no means ends with the part it plays in the reduction and combination

processes. Its ionization effects are discernible in respiration in all of its separate stages. None of the measurements of the action of this important environic component have proven more interesting than those which have been carried out by Professor H. M. Richards and Dr. Spoehr upon the reduction of the acids in plants. Although formed and present in minute quantities in all plants, yet they accumulate and are present in such quantities in the succulent cacti that facile conditions for experimentations are found. The accumulation goes on during darkness so that at daybreak these plants may contain as much as ten times as much acid as at sunset, the diminution during the day being due to the action of light, the disintegration of the acid resulting in formaldehyde and carbon dioxide. Now growth has long been held to be directly retarded by light, it being supposed that the blue-violet rays especially exerted a fixing or destructive action on living matter which prevented growth. That such action did not take place was established by my own experiments on etiolation previous to 1903. The fact remains, however, that growth-expansions and elongations generally go on more rapidly at night than in daytime, and in the determination of the daily fluctuation of acidity we believe to have hit upon the cause of the difference in the rate of growth by day and by night.

Growth is correlated with hydratation, or increase of the water absorbing capacity and consequent swelling of living matter and cell walls in which osmotic pressure must also play a part. Acids may cause such swelling and increase, and this effect would accumulate with the increasing acidity through the night until daybreak, when light begins to break up the acids, and growth-extension would slacken. Light does, therefore, in finality, retard growth not by its action on the components of living matter as formerly supposed, but by breaking up the compounds which increase the water-absorbing power of protoplasm. The controlling environmental features in the growth and development of vegetation are water-absorption or hydratation and temperature.

Some isolated processes of plants, the course of which runs for a short time, such as the action of enzymes upon the starch, which may be accumulated in a tuber or a seed, the germination of seeds or the development of buds, which depends directly upon the hydrolysis of such food material, are found to conform fairly well with van't Hoff's rule by which the rate of activity is about doubled for every rise of 18° F. above the minimum temperature at which it begins. If the entire development of the plant could be interpreted in the same manner the task of estimating the effect of the temperature factor in environment would be a simple one. This is far from the case, however, as any change in temperature may disturb chemical equilibrium in a dozen ways.

The director began a study of this subject in 1900, and first formulated a method by which the total heat-exposure of a locality in which a plant was growing was calculated in hour-degrees, simply as the

product of the number of hours the plant stood above the temperature at which growth began and of the averaged intensities during this period. The method was obviously empirical, as it assumed that the rate of growth was the same at all temperatures above its zero point, which might be freezing or above it.

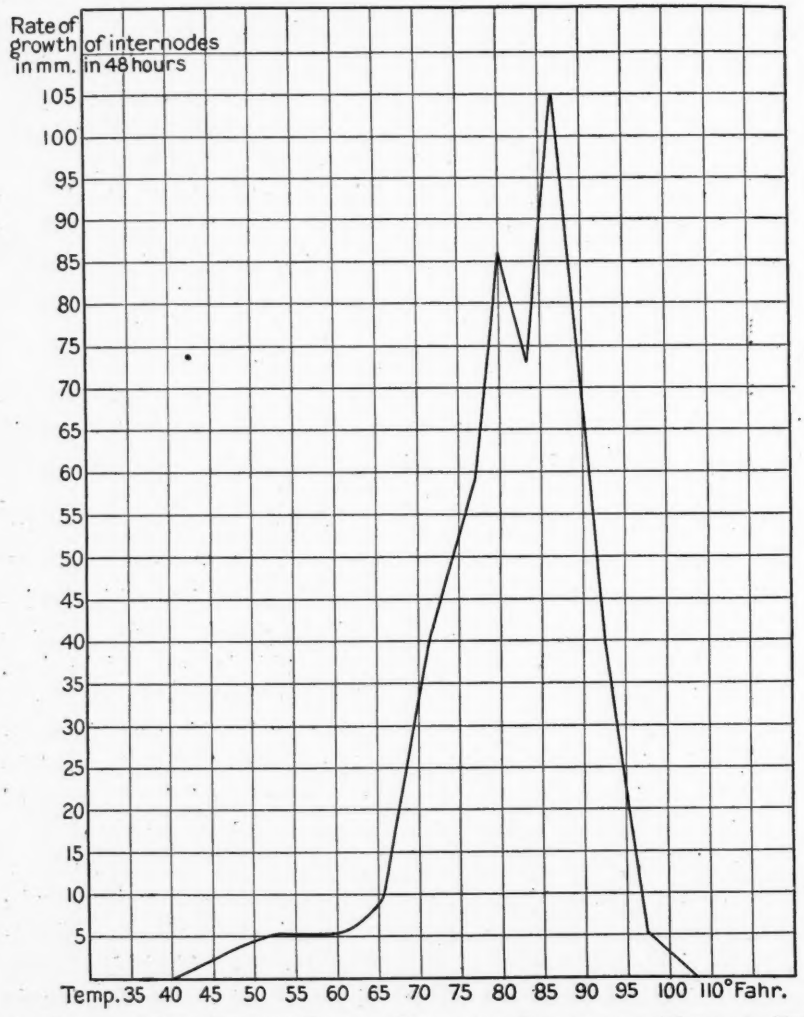


FIG. 6. GRAPH SHOWING RATE OF GROWTH OF SEEDLINGS OF WHEAT AT TEMPERATURES BETWEEN 40° AND 108° F., plotted from data given in text-books of plant physiology.

Next, Professor B. E. Livingston, using the exponential law of chemical velocity in the interpretation of temperature effects, found that survival and distribution of some types of vegetation were explainable upon the temperature integrations arrived at in this manner. This method, however, still depends upon averages or summations of temperature and does not evaluate the higher temperatures correctly as the

plant grows fifteen to twenty times as rapidly at its optimum temperature as it does within ten or fifteen degrees of its zero or minimum. The nature of the experiments upon environic effects, for which some method of temperature evaluation was necessary, demanded greater exactness, and it was finally decided that the actual activity of some plant should be used as a standard of measurement, as the effect of temperature upon growth is one in which chemical equilibrium is disturbed in a score of ways and is therefore not expressible by any single or simple formula. This will be obvious upon the inspection of the graph which shows the relation of temperature to the growth of the hypocotyle of wheat plants determined by measuring the rate at constant temperatures for 48 hours (Fig. 6).

From this it may be seen that growth of the stems takes place at a rate of about 4 to 6 mm. in 48 hours at temperatures between 40° and 65° F. Above this the rate rises precipitously until the temperature reaches 80° F., and if it becomes warmer than this a drop ensues during the next few degrees of rise, then the increase is resumed and carried until a temperature of 86.5° F. is reached. Any further rise in temperature definitely checks growth, which ceases entirely at temperatures of 108° F.

This plant was fixed upon because it is widely grown from subtropical to subarctic localities, reliable measurements have been made of its rate, and it may accompany nearly all of the experimental cultures made in our researches. It is proposed, therefore, to integrate the temperature factor in climate in terms of growth of wheat. Any other suitable species might be used as well. The scheme in brief consists in fixing upon an averaged rate of growth between 40° and 65° F. and then for the five-degree intervals up to the optimum and upper limit. The sheet in which the thermograph has made its tracing of the course of the temperature is now ruled into figures bounded by a

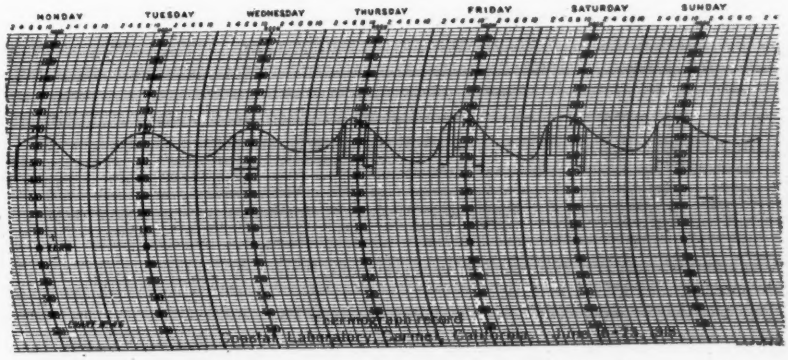


FIG. 7. THERMOGRAPH CHART RULED FOR INTEGRATION IN TERMS OF RATE OF GROWTH. The areas of the separate figures are to be determined by a planimeter and multiplied by the factor expressing the rate of growth prevalent during the period covered by the figures. Record from Coastal Laboratory, June 16-23, 1913.

base line twenty-five degrees below the upper limit of the temperature to be estimated, by arcs of the curves marking the hours, and by the crooked line traced by the pen as a result of changes in temperature, as shown on the accompanying sheet (Fig. 7).

The areas of such figures for temperatures is multiplied by the factor 4.5 for temperatures between 40° and 65° F., and by 20 for temperatures between 65° and 70° F., and by 45 for temperatures

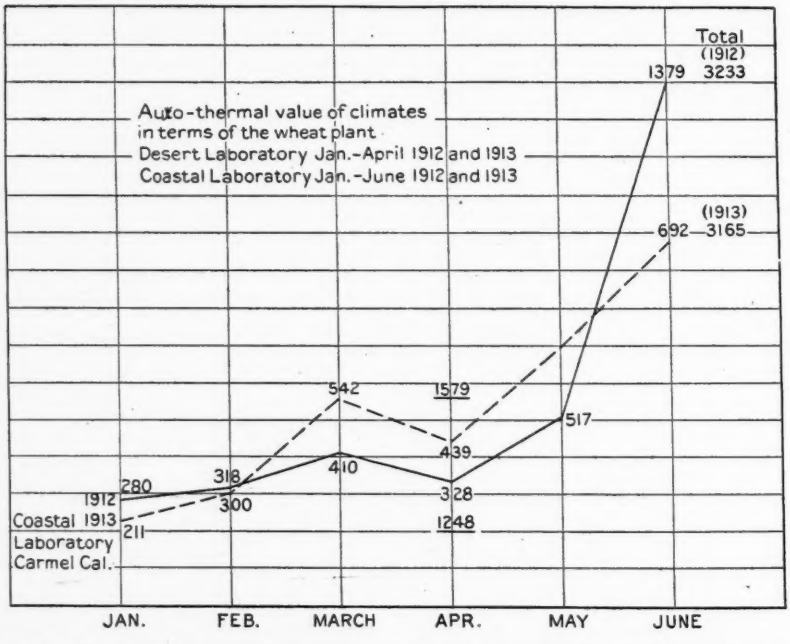


FIG. 8. GROWTH-VALUES DURING THE FIRST SIX MONTHS OF TWO YEARS AT THE COASTAL LABORATORY, CARMEL, CALIF. The solid line shows temperature effects in 1912, the broken line during 1913.

between 70° and 75° F., by 70 for temperatures between 75° and 80° F., by 78 for temperatures between 80° and 86° F., the optimum, etc. Time does not suffice to mention the necessary corrections, or the studies being made for the refinement of the method, but attention may be called to the estimation of the temperature factor by this method at our two main experimental localities during the first four and six months of two years at the Desert Laboratory, and the Coastal Laboratory (Fig. 8). The facts displayed in the accompanying figure go far to explain the divergent action of species under observation in the two places. Studies are now in progress for the redetermination of the factors expressing the rate of growth under the ordinary swing of daily temperatures and for an exacter application of the results.

There is much reason to believe that in the integration of the temperatures and moisture relations by the methods outlined we will be able to identify the causation of the remarkable evolutionary departures

exhibited by the beetles in Professor Tower's experiments, and steps are now being taken for the necessary analytical tests for the standardization of temperature effects in terms of protoplasmic activity.

Another phase of temperature effects—concerning energy release in protoplasm—has been studied by Professor Ellsworth Huntington, whose analysis of the records of piece-workers in factories established the fact that the least amount of work is accomplished with open air temperatures below the freezing point and in the neighborhood of zero Fahrenheit. The amount increases slowly, however, up to 28° F., then rapidly to 38°, slowly to 48° and more slowly to the optimum of 58° F., above which the rate and amount declines as the weather becomes warmer. It may seem a far cry from the growth of a wheat plant in California to the muscular action of a factory operative in New England, but both are directly dependent upon the fundamental characters of living matter, especially in its relation to temperature.

The distribution and grouping of organisms on the world's surface is conditioned by the agencies which participate in moving them from place to place and by the presence of conditions suitable for their survival and existence. If all species inhabited every place suitable for them, geography, so far as vegetation is concerned, would be a subject about which many closed chapters might be written. They do not, however, as they have not been carried to all the places in which they might survive, and secondly, the conditions comprising the environic complex are slowly but surely changing, reversibly or irreversibly, practically everywhere on all land surfaces. Under such conditions the dynamics of plant geography assumes an importance not yet realized.

So far we have discussed the results of analyses of our plantations and experimental settings. The geographer, however, needs to have defined for him the principles governing the variations in the various environmental components and of course temperature is an agency which has been drawn upon to account for some of the major features of distribution in geologic as well as present time. Methods and practises that have become conventionalized estimate temperatures by altitude and latitude, the actual data obtained by instrumentation being compiled as mean temperatures, and the averages of maxima and minima. I need but to refer to the measurements of temperature in terms of growth discussed previously to illustrate the inadequacy of these data for agricultural operations.

The obvious and popularly accepted assumption that low valleys are warm and that ridges are cold wind-swept habitats, arising from the conception of surface temperatures as in the main a function of altitude has been followed much too far, and the geographer who bases his generalizations on assumptions of this kind will be due to encounter some extremely disturbing anomalies, some of which have come in for examination and measurement at the Desert Laboratory by Dr. Shreve.

Forested slopes and bare rocky surfaces do not lose heat at the same rate at night or warm up at the same rate in the daytime. The air cooled on the bare slopes flows down the declivity, collecting in the valleys beneath as would water. Consequently the main building of the Desert Laboratory, 400 feet above the station at the base of Tumamoc hill, is ordinarily 15° to 20° F. warmer than the plantation below at night. This exercises marked influence on the organisms inhabiting these places. In the Santa Catalina mountains in which much of our experimentation is done, this inversion of temperature and collection of cold air operates to give valleys climates equivalent in temperature to the great ridges half a vertical mile higher, in illustration of which it is cited that the cacti, characteristic of warm places, spread highest on the crests of the mountain ridges. The divergence of the temperatures from the normal rate to be expected from increase of temperature may be also illustrated by the following facts:

During the low extremes which characterized the climate of the southwest during the first month of the present year the minima were as follows:

	Actual	Estimated
Desert Laboratory (2,700 feet)	17° F.	....
Breeding plantation (2,300 feet)	1° F.	18° F.
Xero-montane plantation (6,000 feet)	—6° F.	7.6° F.
Rim of Bear Canon (7,000 feet)	.5° F.	3° F.
Montane plantation (8,000 feet)	—2° F.	±.5° F.

If now these places are plotted on a scale in which the vertical element was magnified, but the fall in temperature was computed on the basis of one degree for about every three hundred feet in elevation, it may be seen that the 2,300 feet locality diverges 17° F. from the expectancy by reason of cold air drainage, the 6,000 feet locality is 13.6° F. colder, the 7,000 feet location 2.5° F. colder and the 8,000 feet location 2.5° F. colder. The difference between the mountain top at 8,000 feet and the Desert Laboratory as correspondent to within the limit of possible error, but between these two places ranges the vegetation from the subtropics to the pines under conditions of temperature largely influenced by the relief and orography. The facts which have been brought to light in this single thermometric traverse of a valley and up a mountain slope shows the need of extended surveys for the purpose of evaluating the temperature factor as an agency affecting the distribution of organisms, and when our generalizations can be broadly based and rationally formulated we may also be in a position to furnish the paleontologist with criteria for the better interpretation of the occurrence of the plants and animals found in ancient deposits.

The number of things to be considered in the study of the comparative effects of the different climatic complexes represented at our various plantations make necessary long extended observations coupled with

analytical tests before we may hope to reach any conclusions that may be concisely expressed or widely applied.

The results obtained by the studies which have just been brought to a stage of completion of the Salton Sea furnish us with some very suggestive facts as to the influence of the substratum upon organisms. The waters of this sea when it stood at maximum level in 1907 contained about one fourth of one per cent. of dissolved material, principally salts of sodium, potassium and magnesium. The recession of the lake by evaporation left bare a new strip of strand each year, which was saturated with a solution differing from that of the preceding year by about one fifth of one per cent. in concentration with some changes in relative value of the various substances, especially the calcium and magnesium. Accompanying such conditions, an *Aster*, a *Prosopis*, a *Scirpus* and an *Atriplex* have shown variations not hitherto seen in these species. Especial interest attaches to these occurrences from the fact that there are seven species endemic below the level which the ancient body of water, Blake Sea, must have reached three or four centuries ago. In other words, these seven species are found nowhere but on the beaches of the lake and there is a strong presumption that this restricted occurrence is due to their origination in the place and that they have not spread beyond the ancient sea-bed.

The facts brought out in the foregoing discussion are presented not so much to denote actual progress in our researches as to illustrate the character of some of the problems under consideration. The inquiry as to the integrity of purpose and validity of results of such work is a question which may rightly be directed toward every project which absorbs funds and consumes the time and energy of the investigator and the worker. Something of the wider purposes and fundamental character of the problems attacked are suggested by the results and plans which have been discussed. In addition it seems necessary to say to those who mistakenly attribute a directly economic purpose to the Desert Laboratory that none of its facilities are devoted to agricultural experimentation. This is a function especially pertaining to the government, and so far as our own is concerned a function that is most efficiently carried out. It is clear, however, that the data being accumulated at the Desert Laboratory may in time constitute an important contribution to the physical and biological principles to be considered in the occupation and utilization of arid regions. When it is taken into account that the world-wide progress of civilization with its attendant extended occupancy of the surface of the earth has brought the race to a point where it must consider seriously methods for the more intensive use of the areas already occupied, and also bring into usefulness the arid areas which comprise one fifth of the total land area, the importance of this possibility may be realized.

THE THEORY OF RELATIVITY AND THE NEW MECHANICS

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HE who elects to write on a mathematical topic is confronted with a choice between two evils. He may decide to handle his subject mathematically, using the conventional mathematical symbols, and whatever facts, formulas and equations the subject may demand—save himself who can! Or he may choose to abandon all mathematical symbols, formulas and equations, and attempt to translate into the vernacular this language which the mathematician speaks so fluently. In the one case there results a finished article which only the elect understand, in the other, only a rather crude and clumsy approximation to the truth. A similar condition exists in all highly specialized branches of learning, but it can safely be said that in no other science must one fare so far, and accumulate so much knowledge on the way, in order to investigate or even understand new problems. And so it is with some trepidation that the attempt is made to discuss in the following pages one of the newest and most important branches of mathematical activity. For the writer has chosen the second evil, and, deprived of his formulas, to borrow a figure of Poincaré's, finds himself a cripple without his crutches.

After this mutually encouraging prologue let us introduce the subject with a definition. What is relativity? By relativity, the theory of relativity, the principle of relativity, the doctrine of relativity, is meant a new conception of the fundamental ideas of mechanics. By the relativity mechanics, or as we may sometimes say, the new mechanics, is meant that body of doctrine which is based on these new conceptions. Now this is a very simple definition and one which would be perfectly comprehensible to everybody, provided the four following points were made clear: first, what are the fundamental concepts of mechanics, second, what are the classical notions about them, third, how are these modified by the new relativity principles, and fourth, how did it come about that we have been forced to change our notions of these fundamental concepts which have not been questioned since the time of Newton? These four questions will now be discussed, though perhaps not in this order. The results reached are, to say the least, amazing, but perhaps our astonishment will not be greater than it was when first we learned, or heard rather, that the earth is round, and that there are persons directly opposite us who do not fall off, and stranger yet, do not realize that they are in any immediate danger of doing so.

In the first place then, how has it come about that our conceptions of the fundamental notions of mechanics have been proved wanting? This crime like many another may safely be laid at the door of the physicists, those restless beings who, with their eternal experimenting, are continually raising disturbing ghosts, and then frantically imploring the aid of the mathematicians in order to exorcise them. Let us briefly consider the experiment which led us into those difficulties from which the principle of relativity alone apparently can extricate us.

Consider a source of sound A at rest (Fig. 1), and surrounded by air, in which sound is propagated, also at rest. Now, as every schoolboy knows, the time taken for sound to go to B is the same as that taken to go to C, if B and C are at the same distance from A. The same is true

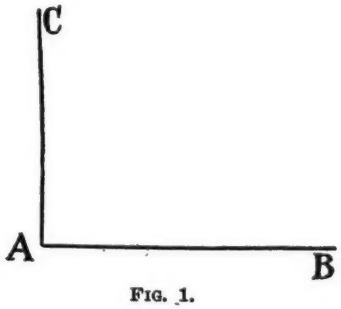

FIG. 1.

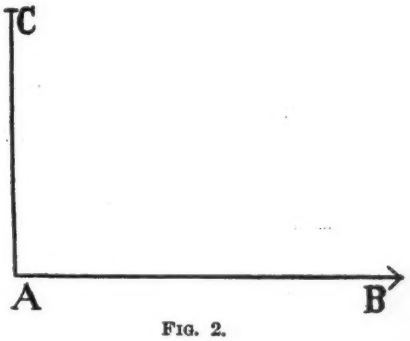

FIG. 2.

also if A, B and C are all moving with uniform velocity in any direction, *carrying the air with them.* This may be realized by a closed railway car or a boat. But if the points A, B, and C are moving with uniform velocity, and the air is at rest relative to them, or what is the same thing, if they are at rest and the air is moving past them with uniform velocity, the state of affairs is very different. If the three points are moving in the direction indicated by the arrow (Fig. 2), and if the air is at rest, and if a sound wave is sent out from A, then the time required for this sound wave to go from A to C is *not the same* as that required to go from A to B. Now as sound is propagated in air, so is light in an imaginary medium, the ether. Moreover, this ether is stationary, as many experiments show, and the earth is moving through it, in its path around the sun with a considerable velocity. Therefore we have exactly the same case as before, and it should be very easy to show that the velocity of light in a direction perpendicular to the earth's direction of motion is different from that in a direction which coincides with it. But a famous experiment of Michelson and Morley, carried out with the utmost precision, showed not the slightest difference in these velocities. So fundamental are these two simple experimental facts, that it will be worth while to repeat them in slightly different form. If the three

points *A, B, C* (Fig. 2), are moving to the right with a uniform unknown velocity through still air, and if a sound wave were sent out from *A*, it would be exceedingly simple to determine the velocity of the point *A* by a comparison of the time necessary for sound to travel from *A* to *B* and from *A* to *C*. But now if the same three points move through stationary ether, and if the wave emanating from *A* is a light wave, there is absolutely no way in which an observer connected with these three points can determine whether he is moving or not. Thus we are, in consequence of the Michelson and Morley experiment, driven to the first fundamental postulate of relativity: The uniform velocity of a body can not be determined by experiments made by observers on the body.

Consider now one of the fundamental concepts of mechanics, time. Physicists have not attempted to define it, admitting the impossibility of a definition, but still insisting that this impossibility was not owing to our lack of knowledge, but was due to the fact that there are no simpler concepts in terms of which time can be defined. As Newton says:

> Absolute and real time flows on equably, having no relation in itself or in its nature to any external object.

Let us examine this statement, which embodies fairly our notion of time, in the light of the first fundamental principle of relativity just laid down. Suppose *A* and *B* (Fig. 3) are two observers, some distance apart, and they wish to set their clocks together. At a given instant agreed upon before hand, *A* sends out a signal, by wireless if you wish, and *B* sets his clock at this instant. But obviously the signal has taken some time to pass from *A* to *B*, so *B*'s clock is slow. But this seems easy to correct; *B* sends a signal and *A* receives, and they take the mean of the correction. But says the first principle of relativity, both *A* and *B* are moving through the ether with a velocity which neither knows, and which neither can know, and therefore the time taken for the signal to pass from *A* to *B* is not the same as that taken to pass from *B* to *A*. Therefore the clocks are not together, and never can be, and when *A*'s clock indicates half-past two, *B*'s does not indicate this instant, and worse yet, there is absolutely no way of determining what time it does indicate. Time then is purely a local affair. The well-known phrase, "at the same instant" has no meaning for *A* and *B*, unless a definition be laid down giving it a meaning. The "now" of *A* may be the "past" or "future" of *B*. To state the case in still other words, two events can no more happen simultaneously at two different places, than can two bodies occupy the same position.

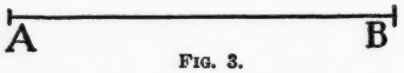

FIG. 3.

But doubtless the reader is anxious to say, this matter of adjusting the clocks together can still be settled. Let there be two clocks having the same rate at a point *A*, and let them be set together. Then let one

of them be carried to the point *B*, can not they then be said to be together? Let us examine this relative motion of one clock with respect to another, in the light of the first principle of relativity. Let there be two observers as before with identical clocks, and for simplicity, suppose *A* is at rest and *B* moving on the line *BX* (Fig. 4). Suppose further *BX* parallel to *AY*. Let now *A* send out a light signal which is reflected on the line *BX* and returns to *A*. The signal has then traveled twice the distance between the lines in a certain time. *B* then repeats the same experiment, for, as far as he knows, he is at rest, and *A* moving in the opposite direction. The signal traverses twice the distance between the lines, and *B*'s clock must record the same interval of time as *A*'s did. But now suppose *B*'s experiment is visible to *A*. He sees the signal leave *B*, traverse the distance between the lines, and return, *but not to the point B*, but to the point to which *B* has moved in consequence of his velocity. That is, *A* sees the experiment as in Fig. 5, where the position of *B'* depends on *B*'s velocity with respect to *A*. The state of affairs is to *A* then simply this: A signal with a certain known velocity has traversed the distance *ABA* while his (*A*'s) clock has registered a certain time interval. The same signal, moving with the same velocity, has traversed the greater distance *BCB'* while *B*'s clock registers exactly the same time interval. The only conclusion is that to *A*, *B*'s clock appears to be running slow as we say, and its rate will depend on the relative velocity of *A* and *B*. Thus we are led to a second conclusion regarding time in the relativity mechanics. To an observer on one body the time unit of another body moving relative to the first body varies with this relative velocity. This last conclusion regarding time is certainly staggering, for it takes away from us what we have long regarded as its most distinguishing characteristic, namely, its steady, inexorable, onward flow, which recognizes neither place nor position nor movement nor anything else. But now in the new mechanics it appears only as a relative notion, just as velocity is. There is no more reason why two beings should be living at the same rate, to coin an expression, than that two railroad trains should be running at the same speed. It is no longer a figure of speech to say that a thousand years are but as yesterday when it is past, but a

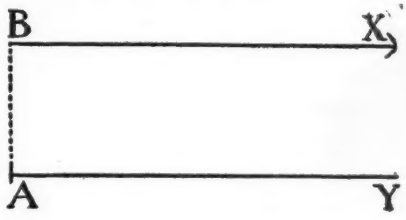

FIG. 4.

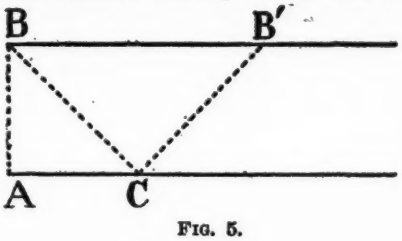

FIG. 5.

thousand years and yesterday are actually the same time interval provided the bodies on which these two times are measured have a sufficiently high relative velocity.

It is to be noted that in the above discussion, use was made of the fact that the light signal sent out by B appeared to A to have the same velocity as one sent out by A himself. This stated in general terms, the velocity of light in free space appears the same to all observers, regardless of the motion of the source of light or of the observer, is the second fundamental postulate of relativity. It is an assumption pure and simple, reasonable on account of the analogy between sound and light, and does not contradict any known facts.

Now there is a second fundamental concept of mechanics, very much resembling time in that we are unable to define it, namely, space. Instead of being one-dimensional, as is time, it is three-dimensional, which is not an essential difference. From the days of Newton and Galileo, physicists have agreed that space like time is everywhere the same, and that it too is independent of any motion or external object. To fix the ideas, consider any one of the units in measuring length, the yard, for example. To be sure, the bar of wood or iron, which in length more or less nearly represents this yard, may vary, as every one knows, in its dimensions, on account of varying temperature or pressure or humidity, or what not, but the yard itself, this unit of linear space which we have arbitrarily chosen, according to all our preconceived notions, neither depends on place nor position, nor motion, nor any other thinkable thing. But let us follow through another imaginary experiment in the light of the two fundamental postulates of relativity. Consider again our two observers A and B (Fig. 6), each furnished with a clock and a yardstick, A at rest, B moving in the direction indicated by the arrow. Suppose A sends out a light signal and adjusts a mirror at C say, so that a ray of light goes from A to C and returns in say one second. A then measures the distance AC with his yardstick and finds a certain number. Then B, supposing that he himself is at rest and A in motion, sends out a light signal and adjusts a mirror at D so that a ray travels the distance BD and back again in one second of his time. B then measures the distance BD with his yardstick, and since the velocity of light is the same in any system, B comes out with the same number of units of length in BD as A found in AC. But A watching B's experiment sees two remarkable facts: first, that the light has not traversed the distance BDB at all, but the greater distance $BD'B'$ (Fig. 7), where D' and B' are the points, respectively, to which D and B

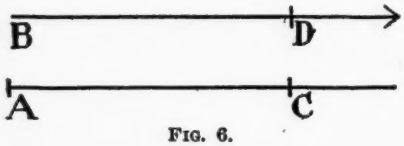

FIG. 6.

have moved in consequence of the motion; second, since *B*'s clock is running slow, the time taken for light to traverse this too great distance is itself too great. Now if too great a distance is traversed in too great a time, then the velocity will remain the same provided the factor which multiplies the distance is the same as that which multiplies the time.

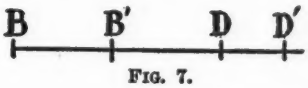

FIG. 7.

But unfortunately, or fortunately, a very little mathematics shows that this multiplier is *not* the same. *A* sees too short a distance being traversed by light in a second of time, and therefore *B*'s yardstick is too short, and by an amount depending on the relative velocity of *A* and *B*. Thus we are led to the astonishing general conclusion of the relativity theory with reference to length: If two bodies are moving relative to each other, then to an observer on the one, the unit of length of the other, measured in the direction of this relative velocity, appears to be shortened by an amount depending on this relative velocity. This shortening must not be looked upon as due to the resistance of any medium, but, as Minkowski puts it, must be regarded as purely a gift of the gods, a necessary accompaniment of the condition of motion. The same objection might be raised here as in the case of the time unit. Perhaps the length of the yardstick *appears* to change, but does the real length change? But the answer is, there is no way of determining the real length, or more exactly, the words real length have no meaning. Neither *A* nor *B* can determine whether he is in motion or at rest absolutely, and if *B* compares his measure with another one traveling with him, he learns nothing, and if he compares it with one in motion relative to him, he finds the two of different length, just as *A* did.

This startling fact, that a railway train as it whizzes past us is shorter than the same train at rest, is at first a trifle disturbing, but how much of our amazement is due to our experience, or lack of it. A certain African king, on beholding white men for the first time, reasoned that as all men were black, these beings, being white, could not be men. Are we any more logical when we say that since in our experience no yardsticks have varied appreciably on account of their velocity, hence it is absurd to admit the possibility of such a thing.

Perhaps it might be well at this point to give some idea of the size of these apparent changes in the length of the time unit and the space unit, although the magnitude is a matter of secondary importance. The whole history of physics is a record of continual striving after more exact measurements, and a fitting of theory to meet new corrections, however small. So it need not occasion surprise to learn that these differences are exceedingly minute; the amazing thing, and the thing of scientific interest, is that they exist at all. If we consider the velocity of

the earth in its orbit, which is about 19 miles per second, the shortening of the earth's diameter due to this velocity as seen by an observer at rest relative to the earth would be approximately a couple of inches only. Similarly for the relative motion of the earth and the sun, the shortening of the time unit would be approximately one second in five years. Even if this were the highest relative velocity known, the results would still be of importance, but the earth is by no means the most rapid in its movement of the heavenly bodies, while the velocity of the radium discharge is some thousand times the velocity of the most rapidly moving planet.

In addition to space and time there is a third fundamental concept of mechanics, though the physicists have not yet settled to the satisfaction of everybody whether it is force or mass. But in any case, the one taken as the fundamental motion, mass say, is, in the classical mechanics, independent of the velocity. Mass is usually defined in physics as the quantity of matter in a body, which means simply that there is associated with every body a certain indestructible something, apart from its size and shape, independent of its position or motion with respect to the observer, or with respect to other masses. But in the relativity mechanics this primary concept fares no better than the other ones, space and time. Without going into the details of the argument by means of which the new results are obtained, and this argument, and the experiment underlying it, are by no means simple, it may suffice to say that the mass of a body must also be looked upon as depending on the velocity of the body. This result would seem at first glance to introduce an unnecessary and almost impossible complication in all the considerations of mechanics, but as a matter of fact exactly the opposite is true. It has been known for some time, that electrons moving with the great velocity of the electric discharge, have suffered an apparent increase of mass or inertia due to this velocity, so that physicists for some time have been accustomed to speak of material mass and electromagnetic mass. But now in the light of the principles of relativity, this distinction between material mass and electromagnetic mass is lost, and a great gain in generality is made. *All* masses depend on velocity and it is only because the velocity of the electric discharge approaches that of light, that the change in mass becomes striking. This perhaps may be looked upon as one of the most important of the consequences of the theory of relativity in that it subjects electromagnetic phenomena to those laws which underlie the motions of ordinary bodies.

In consequence of this revision of our notions of space, time and mass, there result changes in the derived concepts of mechanics, and in the relations between them. In fact the whole subject of mechanics has had to be rewritten on this new basis, and a large part of the work of those interested in the relativity theory has been the building up of the

mathematics of the new subject. Some of the conclusions, however, can be understood without much mathematics. For example, we can no longer speak of a particle moving in space, nor can we speak of an event as occurring at a certain time. Space and time are not independent things, so that when the position of a point is mentioned, there must also be given the instant at which it occupied this position. The details of this idea, as first worked out by Minkowski, may be briefly stated. With every point in space there is associated a certain instant of time, or to drop into the language of mathematics for a moment, a point is determined by four coordinates, three in space and one in time. We still use the words space and time out of respect for the memory of these departed ideas, but a new term including them both is actually in use. Such a combination, *i. e.,* a certain something with its four coordinates, is called by Minkowski a *world point.* If this world point takes a new position, it has four new coordinates, and as it moves it traces out in what Minkowski calls the *world,* a *world-line.* Such a world-line gives us then a sort of picture of the eternal life history of any point, and the so-called laws of nature can be nothing else than statements of the relations between these world-lines. Some of the logical consequences of this world-postulate of Minkowski appear to the untrained mind as bordering on the fantastic. For example, the apparatus for measuring in the Minkowskian world is an extraordinarily long rod carrying a length scale and a time scale, with their zeros in coincidence, together with a clock mechanism which moves a hand, not around a circle as in the ordinary clock, but along the scale graduated in hours, minutes and seconds.

Some of the conclusions of the relativity mechanics with reference to velocity are worth noting. In the classical mechanics we were accustomed to reason in the following way: Consider a body with a certain mass at rest. If it be given certain impulse, as we say, it takes on a certain velocity. The same impulse again applied doubles this velocity, and so on, so that the velocity can be increased indefinitely, and can be made greater than any assigned quantity. But in the relativity mechanics, a certain impulse produces a certain velocity, to be sure; this impulse applied again does not double the velocity; a third equal impulse increases the velocity but by a still less amount, and so on, the upper limit of the velocity which can be given to a body being the velocity of light itself. This statement is not without its parallel in another branch of physics. There is in heat what we call the absolute zero, a value of the temperature which according to the present theory is the lower limit of the temperature as a body is indefinitely cooled. No velocity then greater than the velocity of light is admitted in the relativity mechanics, which fact carries with it the necessity for a revision of our notion of gravitational action, which has been looked upon as instantaneous.

In consequence of the change in our ideas of velocity, there results a change in one of the most widely employed laws of velocity, namely the parallelogram law. Briefly stated, in the relativity mechanics, the composition of velocities by means of the parallelogram law is no longer allowable. This follows evidently from the fact that there is an upper limit for the velocity of a material body, and if the parallelogram law were to hold, it would be easy to imagine two velocities which would combine into a velocity greater than that of light. This failure of the parallelogram law to hold is to the mathematician a very disturbing conclusion, more heretical perhaps than the new doctrines regarding space and time.

Another striking consequence of the relativity theory is that the hypothesis of an ether can now be abandoned. As is well known, there have been two theories advanced in order to explain the phenomena connected with light, the emission theory which asserts that light effect is due to the impinging of particles actually sent out by the source of light, and the wave theory which assumes that the sensation we call light is due to a wave in a hypothetical universal medium, the ether. Needless to say this latter theory is the only one which recently has received any support. And now the relativists assert that the logical thing to do is to abandon the hypothesis of an ether. For they reason that not only has it been impossible to demonstrate the existence of an ether, but we have now arrived at the point where we can safely say that at no time in the future will any one be able to prove its existence. And yet the abandoning of the ether hypothesis places one in a very embarrassing position logically, as the three following statements would indicate:

1. The Michelson and Morley experiment was only possible on the basis of an ether hypothesis.

2. From this experiment, follow the essential principles of the relativity theory.

3. The relativity theory now denies the existence of the ether. Whether there is anything more in this state of affairs than mere filial ingratitude is no question for a mathematician.

It should perhaps be pointed out somewhat more explicitly that these changes in the units of time, space and mass, and in those units depending on them, are changes which are ordinarily looked upon as psychological and not physical. If we imagine that A has a clock and that about him move any number of observers, $B, C, D, \ldots$, in different directions and with different velocities, each one of these observers sees A's clock running at a different rate. Now the actual physical state of A's clock, if there is such a state, is not affected by what each observer thinks of it; but the difficulty is that there is no way for any one except A to get at the actual state of A's clock. We are then driven to one of the two alternatives: Either we must give up all notion of time at all,

for bodies in relative motion, or we must define it in such a way as will free it of this ambiguity, and this is exactly what the relativity mechanics attempts to do.

Any discussion of the theory of relativity would be hardly satisfactory without a brief survey of the history of the development of the subject. As has been stated, for many years the ether theory of light has found general acceptance, and up to about twenty-five years ago practically all of the known phenomena of light, electricity and magnetism were explained on the basis of this theory. This hypothetical ether was stationary, surrounded and permeated all objects, did not, however, offer any resistance to the motion of ponderable matter. There came then, in 1887, into this fairly satisfactory state of affairs, the famous Michelson and Morley experiment. This experiment was directly undertaken to discover, if possible, the so-called ether drift.

In this experiment, the apparatus was the most perfect that the skill of man could devise, and the operator was perhaps one of the most skilful observers in the world, but in spite of all this no result was obtained. Physicists were then driven to seek some theory which would explain this experiment, but with varying success. It was proposed that the ether was carried along with the earth, but a host of experiments show this untenable. It was suggested that the velocity of light depends on the velocity of the source of light, but here again there were too many experiments to the contrary. Michelson himself offered no theory, though he suggested that the negative result could be accounted for by supposing that the apparatus underwent a shortening in the direction of the velocity and due to the velocity, just enough to compensate for the difference in path. This idea was later, in 1892, developed by Lorentz, a Dutch physicist, and under the name of the Lorentz-shortening hypothesis has had a dignified following. The Michelson and Morley experiment, together with certain others undertaken for the same purpose, remained for a number of years as an unexplained fact—a contradiction to ascertained well-established and orderly physical theory. Then there appeared in 1905, in the *Annalen der Physik,* a modest article by A. Einstein, of Bern, Switzerland, entitled, " Concerning the Electrodynamics of Moving Bodies." In this article Einstein, in a very unassuming way, and yet in all confidence, boldly attacked the problem and showed that the astonishing results concerning space and time which we have just considered, all follow very naturally from very simple assumptions. Naturally a large part of his paper was devoted to the mathematical side—to the deduction of the equations of transformation which express mathematically the relation between two systems moving relative to each other. It may safely be said that this article laid the foundation of the relativity theory.

Einstein's article created no great stir at the time, but within a

couple of years his theory was claiming the attention of a number of prominent mathematicians and physicists. Minkowski, a German mathematician of the first rank, just at this time turning his attention to mathematical physics, came out in 1909 with his famous world postulate, which has been briefly described. It is interesting to note that within a year translations of Minkowski's article appeared in English, French and Italian, and that extensions of his theories have occupied the attention of a number of Germany's most famous mathematicians. Next Poincaré, perhaps the most brilliant mathematician of the last quarter century, stamped the relativity theory with the unofficial approval of French science, and Lorentz, of Holland, one of the most famous in a land of famous physicists, aided materially to the development of the subject. Thus we find within five years of the appearance of Einstein's article, a fairly consistent body of doctrine developed, and accepted to a surprising degree by many of the prominent mathematical physicists of the foremost scientific nations. No sooner was the theory in a fairly satisfactory condition, than the attempt was made to verify some of the hypotheses by direct experiment. Naturally the difficulties in the way of such experimental verification were very great—insurmountable in fact for many experiments, since no two observers could move relative to each other with a velocity approaching that of light. But the change in mass of a moving electron could be measured, and a qualitative experiment by Kaufmann, and a quantitative one by Bucherer gave results which were in good agreement with the theoretical equations. It was the hope of the astronomers that the new theory would account for the long-outstanding disagreement between the calculated and the observed motion of Mercury's perihelion, but while the relativity mechanics gave a correction in the right direction, it was not sufficient. To bring this very brief historical sketch down to the present time, it will perhaps be sufficient to state that this theory is at present claiming the attention of a large number of prominent mathematicians and physicists. The details are being worked out, the postulates are being subjected to careful mathematical investigation, and every opportunity is being taken to substantiate experimentally those portions of the theory which admit of experimental verification. Practically all of the work which has been done is scattered through research journals in some six languages, so that it is not very accessible. Some idea of the number of articles published may be obtained from the fact that a certain incomplete bibliography contains the names of some fifty-odd articles, all devoted to some phase of this subject—varying all the way from the soundest mathematical treatment, at the one end of the scale, to the most absurd philosophical discussion at the other. And these fifty or more articles include only those in three languages, only those which an ordinary

mathematician and physicist could read without too great an expenditure of time and energy, and with few exceptions, only those which could be found in a rather meager scientific library.

In spite of the fact that the relativity theory rests on a firm basis of experiment, and upon logical deductions from such experiments, and notwithstanding also that this theory is remarkably self-consistent, and is in fact the only theory which at present seems to agree with all the facts, nevertheless it perhaps goes without saying that it has not been universally accepted. Some objections to the theory have been advanced by men of good standing in the world of physics, and a fair and impartial presentation of the subject would of necessity include a brief statement of these objections. I shall not attempt to answer these objections. Those who have adopted the relativity theory seem in no wise concerned with the arguments put forward against it. In fact, if there is one thing which impresses the reader of the articles on relativity, it is the calm assurance of the advocates of this theory that they are right. Naturally the theory and its consequences have been criticized by a host of persons of small scientific training, but it will not be necessary to mention these arguments. They are the sort of objections which no doubt Galileo had to meet and answer in his famous controversy with the Inquisition. Fortunately for the cause of science, however, the authority back of these arguments is not what it was in Galileo's time, for it is not at all certain just how many of those who have enthusiastically embraced relativity would go to prison in defence of the dogma that one man's now is another man's past, or would allow themselves to be led to the stake rather than deny the doctrine that the length of a yardstick depends upon whether one happens to be measuring north and south with it, or east and west.

In general it may be said that the chief objection to the relativity theory is that it is too artificial. The end and aim of the science of physics is to describe the phenomena which occur in nature, in the simplest manner which is consistent with completeness, and the objectors to the relativity theory urge that this theory and especially its consequences, are not simple and intelligible to the average intellect. Consider, for example, the theory which explains the behavior of a gas by means of solid elastic spheres. This theory may be clumsy, but it is readily understood, rests upon an analogy with things which can be seen and felt, in other words is built up of elements essentially simple. But the objectors to the relativity theory say that it is based on ideas of time and space which are not now and which never can be intelligible to the human mind. They claim that the universe has a real existence quite apart from what any one thinks about it, and that this real universe, through the human senses, impresses upon the normal mind certain simple notions which can not be changed at will. Minkowski's

famous world-postulate practically assumes a four-dimensional space in which all phenomena occur, and this say the objectors, on account of the construction of the human mind, can never be intelligible to any one in spite of its mathematical simplicity. They insist that the words space and time, as names for two distinct concepts, are not only convenient, but necessary. Nor can any description of phenomena in terms of a time which is a function of the velocity of the body on which the time is measured ever be satisfactory, simply because the human mind can not now nor can it ever appreciate the existence of such a time. To sum up, then, this model of the universe which the relativists have constructed in order to explain the universe, can never satisfactorily do this, for the reason that it can never be intelligible to everybody. It is a mathematical theory and can not be satisfactory to those lacking the mathematician's sixth sense.

A second serious objection urged against the relativity theory is that it has practically abandoned the hypothesis of an ether, without furnishing a satisfactory substitute for this hypothesis. As has been previously stated, the very experiment which the relativity theory seeks to explain depends on interference phenomena which are only satisfactorily accounted for on the hypothesis of an ether. Then too, there are in electromagnetism certain equations of fundamental importance, known as the Maxwell equations, and it is perhaps just as important that the relativity theory retain these equations, as it is that it explain the Michelson and Morley experiment. But the electro-magnetic equations were deduced on the hypothesis of an ether, and can be explained, or at least have been explained only on the hypothesis that there is some such medium in which the electric and magnetic forces exist. So, say the objectors to the relativity theory, the relativists are in the same illogical (or worse) position that they occupy with reference to the Michelson and Morley experiment, in that they deny the existence of the medium which made possible the Maxwell equations, which equations the relativity theory must retain at any cost. Professor Magie, of Princeton, who states with great clearness the principal objections to the theory, waxes fairly indignant on this point, and compares the relativists to Baron Munchausen, who lengthened a rope which he needed to escape from prison, by cutting off a piece from the upper end and splicing it on the lower. The objectors to the relativity theory point out that there have been advocated only two theories which have explained with any success the propagation of light and other phenomena connected with light, and that of these two, only the ether theory has survived. To abandon it at this time would mean the giving up of a theory which lies at the foundation of all the great advances which have been made in the field of speculative physics.

It remains finally to ask and perhaps also to answer the question,

whither will all this discussion of relativity lead us, and what is the chief end and aim and hope of those interested in the relativity theory. The answer will depend upon the point of view. To the mathematician the whole theory presents a consistent mathematical structure, based on certain assumed or demonstrated fundamental postulates. As a finished piece of mathematical investigation, it is, and of necessity must remain, of theoretical interest, even though it be finally abandoned by the physicists. The theory has been particularly pleasing to the mathematician in that it is a generalization of the Newtonian mechanics, and includes this latter as a special case. Many of the important formulas of the relativity mechanics, which contain the constant denoting the velocity of light become, on putting this velocity equal to infinity, the ordinary formulas of the Newtonian mechanics. Generality is to the mathematician what the philosopher's stone was to the alchemist, and just as the search for the one laid the foundation of modern chemistry, so is the striving after the other responsible for many of the advances in mathematics.

On the other hand, those physicists who have advocated the theory of relativity see in it a further advance in the long attempt to rightly explain the universe. The whole history of physics, is, to use a somewhat doubtful figure of speech, strewn with the wrecks of discarded theories. One does not have to go back to the middle ages to find amusing reading in the description of these theories, which were seriously entertained and discarded only with the greatest reluctance. But all the arguments of the wise, and all the sophistries of the foolish, could not prevent the abandoning of a theory, if a few stubborn facts were not in agreement with it. Of all the theories worked out by man's ingenuity, no one has seemed more sure of immortality than the one we know as the Newtonian mechanics. But the moment a single fact appears which this system fails to explain, then to the physicist with a conscience this theory is only a makeshift until a better one is devised. Now this better one may not be the relativity mechanics—its opponents are insisting rather loudly that it is not. But in any case, the entire discussion has had one result pleasing alike to the friends and foes of relativity. It has forced upon us a fresh study of the fundamental ideas of physical theory, and will give us without doubt, a more satisfactory foundation for the superstructure which grows more and more elaborate.

It can well happen that scientists, some generations hence, will read of the relativity mechanics with the same amused tolerance which marks our attitude towards, for example, Newton's theory of fits of easy transmission and reflection in his theory of the propagation of light. But whatever theory may be current at that future time, it will owe much to the fact that in the early years of the twentieth century, this same relativity theory was so insistent and plausible, that mathe-

maticians and physicists in sheer desperation were forced either to accept it, or to construct a new theory which shunned its objectionable features. Whether the relativity theory then is to serve as a pattern for the ultimate hypothesis of the universe or whether its end is to illustrate what is to be avoided in the construction of such a hypothesis, is perhaps after all not the important question.

THE SMALL COLLEGE AND ITS PRESIDENT

By ONE OF ITS PROFESSORS

THE institution which must here be described merely as "our college" is one of a large class, of which it may be taken as a typical specimen. It is located in a thriving middle-western town of a little over thirty thousand population. It has a faculty of twenty, a student body numbering a little less than five hundred, a campus of ten acres in the heart of the town, seven good buildings, three of which have been built within the past ten years, endowed funds of over half a million dollars, and library and laboratory equipment fairly adequate to present needs. It enjoys what its trustees and some of its faculty regard as the high distinction of a place on the accepted list of the Carnegie Foundation. While in scholarship standards it may rank below some of the smaller colleges of our state, it is superior to others, and certainly does not fall below the average. There is of course the inevitable weak department, filled by an incumbent whose innocuous "Christian character" is his only recommendation. On the other hand, there are strong departments whose work commands outside recognition in the world of scholars, and whose class-room standards provoke wholesome respect on the part of students. Striking an average, it may be said without exaggeration that, measured by the ideals of its teachers, the college stands for a high grade of scholarship, while measured by the results achieved its standard is barely respectable. In fact, there is far too wide a gap between ideals and achievement, between profession and performance, and it shall be in part the purpose of the present article to trace some of the causes of this unfortunate discrepancy.

Many more or less obvious reasons suggest themselves. Insufficient equipment is frequently assigned as the cause of our shortcoming; yet this is a most inadequate excuse. While not all that it ought to be, the equipment of the college is not bad. Great scholars, both in the humanities and the sciences, have been trained on poorer material equipment than ours. Inbreeding may be suggested by the outsider who reads our catalogue and observes that seven teachers out of twenty were trained at the home college. This suggestion is not without weight, for in colleges as in human families inbreeding tends to accentuate the defects, yet a good majority of the faculty were trained in eastern universities, and the third who took their bachelor's degree here have had their courses at higher institutions, with a chance to absorb university methods and ideals. While inbreeding has been anything but a benefit to the college, it would be grossly unfair to hold it responsible for all our shortcomings.

The low salary paid is a more potent cause of failure, and more generally recognized—especially in faculty circles. Married professors are expected to live on salaries ranging from a thousand to fifteen hundred dollars, pay from twenty-five to thirty dollars a month house rent (for houses can not be had in our section of town for less), dress in such fashion as to be be able on occasion to meet the trustees and their friends socially, and contribute to the formal entertainment of the student body four or five times a year. Needless to say, after the satisfaction of these demands nothing remains for the purchase of books, for travel or for study at eastern or European universities. The professor and his family are fortunate if they get through a year without running deeply in debt, and the almost inevitable result of an illness in the family or other unforeseen catastrophe is the starting of a train of evils from which the unfortunate teacher escapes—if he escape at all—only by finding a better paid position in some larger institution. Most of our faculty are so harassed by financial worries that their efficiency as teachers is seriously impaired. Such a condition as this might seem explanation enough of our failure to secure the best results, yet, serious as it is, it is not the fundamental difficulty in our college. It is a symptom rather than a primary cause.

A few courageous professors might so far endanger their popularity as to suggest that the overemphasis placed on athletics has some relation to our failure in realizing our ideals, and in this they would not fall far short of the mark, yet after all the explanation is not entirely satisfying. The overemphasis placed on athletics is in the final analysis but a symptom. The disease from which the college suffers might exist were there no such thing as athletics, and it were unfair to make athletics alone the scapegoat.

The trouble that afflicts our college and other colleges of its class is one that can not be cured by the excision of this or that diseased part. The situation, indeed, does not lend itself kindly to the metaphors of surgery; would we describe it truly we must employ a spiritual metaphor, for it is a rebirth that our college needs, and only by a rebirth can it be saved. The root of the difficulty lies deep in its very constitution. If we would discover why the institution has more or less persistently and systematically fallen short of its recognized duty, and prostituted its own ideals, we must look for the ultimate cause in its fundamental organization.

Ere we depart on this quest, however, let it be clearly understood that the personal ideals of the faculty with regard to scholarship are, for the most part, absolutely irreproachable. We know what sound scholarship is, and we honestly recognize the fact that we are not giving our students all that we ought to give them, though naturally we do not make the fact a subject for general conversation. Neither do we admit that the cause of this condition lies entirely within our own control. The

ethical nature of the excuse that "a man must live" may be called in question, but no married man dare question the validity of the corollary that "a man's family must live," nor blame the teacher who, with wife and children dependent on him, places bread and butter ahead of ideals and starvation. On these stern conditions the teacher is often forced to countenance practises which he knows to be fundamentally wrong; and on the same stern conditions he is often forced to assume public responsibility for these same practises. If he protest, he is curtly told that teachers are not wanted who can not loyally support the institution and its policies, and is given the choice of upholding a policy which he knows to be harmful or of tendering his resignation. In short, while they are not allowed any appreciable share in determining the policies of the college, the faculty are forced to pose as the authors of these same policies, and criticism of any one of them is sufficient ground for a charge of "disloyalty" to the institution, and often a threat of dismissal from one's position. In all such matters, the teacher is not a free agent. He acts virtually under duress. The real responsibility for existing conditions must be sought elsewhere.

Above the faculty stands the board of trustees, a self-perpetuating body governing the college from without, sometimes with slight sympathy for the views of those within. The power of the board is absolute; its will is the supreme law of the college. For the most part it is made up of successful business men, few of whom are in agreement with the ideals of the faculty, many of whom indeed are incapable of understanding such ideals. They are keen, enterprising men, who have made money, who are proud of their business, intensely if blindly loyal to the town, and always ready to push its interests in season and out. They are proud of the fact that we have a college here. Its presence advertises us as a literate people, and it attracts new families to the town, thus "making business." While some of them have a rather hazy idea as to what college is for, they are very sure it is a fine thing, and they are willing to work for it, spend time and money for it, and use their utmost endeavors to advertise it effectively. Standards of scholarship are beyond their comprehension, but size appeals to them, for to them size and success are synonymous terms. They are ambitious for a big town and a big college. Whether the latter shall be a center of sound scholarship or merely a degree mill is a question that is not considered; indeed, the very meaning of such a problem is beyond the comprehension of most of them. Theirs is the narrowly commercial point of view, and they are constitutionally incapable of appreciating any problem that can not be expressed in commercial terms.

"M—— is to be asked to resign on account of inefficiency," declared a member of our board of trustees, in the hearing of a friend.

"But I had supposed M—— to be highly efficient," objected the friend. "He has certainly had fine training in his subject, and all who

have heard him say that his teaching is splendidly clear and thorough."

"O yes," was the reply, "of course he can teach—we take that for granted—but as a *booster* the man is a flat failure. He never gets out and does a thing for the college—just keeps himself shut up in his laboratory all the time. For all the good he does he might just as well not be here."

Between the faculty, with its ideal of scholarship, and the trustees with their ideal of commercialism, stands the president of the college. Employed by the trustees as executive head of the institution, he has been given great power and broad discretion. In all matters touching the internal affairs of the college he is the confidential adviser of the board, and his advice is seldom disregarded. The board have placed in his hands the right of employing and discharging teachers at will, and without assigned cause. While certain powers are supposed to belong to the faculty, the president may not only veto, but may by executive order reverse its decisions, and in such cases his decision is final. It is true that cases of this sort may be appealed to the trustees, but it is an axiom of the trustees that, so long as they retain a president, he is to be supported in all that he does. As a practical proposition, therefore, in case of any disagreement between faculty and executive, the faculty enjoy only so much authority as the president may choose to allow them, and if he sees fit to overrule them completely they have no recourse. The president is in fact an autocrat, and the college policy is largely the reflection of his individual will.

It must not be supposed however that the board of trustees is a mere negative quantity, without opinions as to the conduct of the institution. The president's opinion is law, but the president's opinion is likely to be the reflection of the opinions of his more influential trustees. He is the creature of the trustees and depends upon them for his office. Were his views to take color unconsciously from those of any other man or body of men, one would expect that it would be the trustees whose opinions would determine his. His faculty have no means of asserting themselves, and are, accordingly, not in a position to command his respect. In the organization of the college they have been deprived of all real authority. They stand powerless before the president, as he would stand powerless before the trustees were there to be a conflict of authority between them. Naturally his views of college policy are modeled after those of the men who control him rather than those of the men and women who are so abjectly under his control. He comes quite naturally to attach too high a value to the commercialistic factor in the college problem, because that is the factor that appeals to his trustees. He discredits the views of his faculty whenever they conflict with the prevailing views of the trustees, even when such subjects as academic standards are concerned, in which it must be supposed that the faculty are experts and the trustees are not. There is, therefore, to-day a broad and ever-

widening breach between president and faculty in our college. Socially the best of feeling exists. Officially there is a lack of understanding between the teaching and administrative ends of the institution.

The fact that the president is not himself a teacher tends to widen this breach between his faculty and himself. However much pressure might be brought to bear upon an executive by a commercialistic board, it is hard to believe that any man who had himself occupied a chair of instruction could, as president, forget to take account of the dangers that beset the scholastic ideals of the college at every turn. Nobody who has not served for some years as a college teacher can have any adequate realization of these dangers. Only the teacher knows the strength of the pressure that is brought to bear day after day, month after month, and year after year, for the scaling down of the passing standard, the destruction of effective discipline, the currying of favor by the introduction of "snap" courses, and the virtual abrogation of all rules in favor of successful athletes. Athletics indeed is the most frequent excuse urged in extenuation of the breaking down of an effective standard of work, and the statement that a boy is "representing the college" is apparently regarded by president, trustees and public at large as ample warrant for excusing him from any decent pretence of work and presenting him with an A or B grade merely as a compliment to his prowess as college "representative." Athletics is not the only occasion, however, for the manifestation of this spirit, and more than one professor has found himself in serious difficulty because of his failure to show a delicate sense of diplomacy in discriminating among the students who have failed in his department. Those who have trained themselves to see these things from the angle of the business office understand that such matters must be settled with due regard for the commercial rating of the student's family. "The boy's people are wealthy, and have always been friendly to the college" is regarded as valid excuse for undue leniency on such occasions. Against such insidiously demoralizing influences as these the more conscientious and discerning of the faculty struggle as best they can, and the fruit of their effort is seen in the fact that during the past half decade there has been a stiffening of class-room standards throughout the college. Yet the condition is still far from what it ought to be, and it is no exaggeration to say that such improvement as has come has been brought about in spite of the president and not because of him. While acutely anxious to safeguard our popularity he has apparently been unaware of the fact that standards of college work also need safeguarding, and that to this end eternal vigilance is necessary. Had he ever been a college teacher, it would have been impossible for him to overlook this very obvious fact. It is to his ignorance of the college, as seen from the teacher's side, that we must attribute his failure in this respect. Before becoming a college president he was a minister, as were the presidents of most of the colleges of our state. Out

of our thirty-one small colleges only nine have chosen laymen to the presidency.

Most of these colleges are, of course, still under denominational control, and while such is not the case with our college, tradition demands that a clergyman fill the presidential chair. This tradition is doubtless a survival from the days when ours also was a strictly denominational college. We still have a large clientéle in the state who cherish the fear that the choosing of a layman for the presidency would be the last step in the secularization, and therefore the demoralization of the college, that it would thenceforth lose its character as a Christian college and would become "Godless" in its tendencies. Just how sectarianism contributes to the development of Christian character is not explained, nor is it made satisfactorily clear in what way a wise and well-trained teacher would fall short as an executive. Sooner or later this ministerial tradition must be dispensed with, for we must eventually realize that the only truly competent executive is the one who has "been through the mill" and has risen to the presidency from the ranks of college teachers; nor will the character of the college as a Christian institution suffer in the least by the appointment of such a man. Rather is it likely that our Christianity may take on a somewhat deeper tone, and find its vent in somewhat more practical manifestations. There may come to be less preaching and more performance, less self-conscious talk about the state of one's soul, and at the same time less cheating in examinations; for present experience indicates that religion of the current type and dishonesty of a conventional sort are not at all incompatible. Our inherited brand of Christianity is sincere but narrow, issuing at best in a personal righteousness that fails to take account of the broader social responsibilities confronting the present age. It is to be hoped that our college will ere long cast aside its theological leading strings and grow into something broader and better than its present pseudo-sectarianism.

Undoubtedly one of the worst effects of our president's failure to recognize scholarship as our goal is its demoralizing effect on members of the faculty. Left to themselves, there is no doubt that our teachers would pursue scholarship as the end and aim of their professional efforts. But as things stand at present, those who engage in this lofty pursuit are neither encouraged nor appreciated. Our president wants "rustlers"—men who are ready at a day's notice to leave their classes and go out on a financial campaign or a student canvass, men who are continually in the lime-light, attending committee meetings, speaking to student gatherings, devising changes in the man-millinery which is the outward and visible sign of our high calling, addressing questionnaires to the rest of the faculty on all sorts of unimportant topics, tacking up notices in the halls, rushing officiously from place to place, and making themselves generally as conspicuous as possible. Our president is a fanatic on the subject of "efficiency," by which term he means

merely "activity." He has not yet discovered that much of this activity is about as fruitful as the activity of a kitten chasing its tail. His ideal —copied from that of his trustees—is commercial and material. Fruitful or not, the activity must be outward and evident, lending itself readily to advertising purposes; and for quiet unremitting intellectual labor, issuing in broader learning, deeper culture and better teaching, he has scant appreciation. What wonder that more than one teacher has become a mere promoter, letting his department deteriorate most woefully while he assists in the "broader" task of "running the college." Such is the sure road to presidential favor. Were our president himself a college teacher, viewing matters from the teacher's angle, this condition could not exist; but he is a promoter, employed by a group of promoters to advertise this educational undertaking of ours, and he sees the college from the promoter's viewpoint.

Yet even supposing the college headed by an experienced professor, with breadth enough to appreciate the needs of all the various departments, financial ability enough to make a good business manager, and courage enough to fight if necessary for the integrity of collegiate standards; could it under such conditions run smoothly and effectively? Probably not! Probably the man does not live who could fully satisfy the conflicting demands of faculty, trustees, student body and general public. It is time indeed that the student body and general public were left out of account in the consideration of this problem. Current opinion to the contrary notwithstanding, the college that will abandon the policy of inflation will be content with a small student body strictly selected from the available output of the high schools, and will make no effort to harvest as large a crop of freshman as possible, will soon have more students knocking at its doors than it can possibly accommodate. The annual scramble for students is a most undignified performance. It gives the public a false impression of the college, and leaves in the mind of the freshman a most exaggerated idea of his own indispensability in the educational scheme of things. Our college, like others, has cheapened itself in this respect. It is time that it learned its own worth, and realized that it is to be sought rather than to seek. But, leaving student body and public out of account, it may be asked whether our model college president could satisfy at the same time the ideals of the faculty and the ambitions of the trustees. Probably not. It was said at the outset that the disease from which our college suffers is constitutional, and that what it needs is a rebirth, that is to say, a reorganization along radically new lines. To vary the figure, let us say that the old educational machinery was awkward and poorly constructed in the first place, it never worked well, and with the changing demands of the times it works more and more poorly. We in America, inventive enough along mechanical lines, have been strangely uninventive in the organization of our educational institutions. Early in our history there

grew up a form of college organization, adequate enough for its day, but fraught with potentialities of serious danger for the future. The president, in that early time, although usually a clergyman, was a teacher also, and met classes like the rest of the faculty. His was not then a position of great power. He was *primus inter pares*—the senior member of the faculty and the presiding officer in its meetings—not the Czar that he has since become. The American college was poor in those days, and its scanty funds were held in trust by a body of men who, that they might be impersonal and disinterested, were chosen from outside the college. As the college grew in wealth this group of trustees grew in importance, and gradually assumed not simply the investment of college funds, but the actual management of the college itself. Needing a representative within the college, they naturally chose the president, conferring on him autocratic authority, and correspondingly curtailing the power of the faculty. Thus grew up, gradually, a makeshift system of college government that could hardly be worse. The wonder is not that it works so poorly; the wonder is that it works at all; yet for many generations this system has been reduplicated all over the United States with scarcely a thought of the possibility of an improvement. Our college is merely one of the many that have copied this viciously undemocratic model, incorporating its worst features into their charters.

Trustees, president and faculty alike suffer from this bad condition of things. The faculty, being debarred from the exercise of their natural functions, become firebrands of discontent, or relapse in fatalistic apathy, or become parasitic sycophants fawning on president and trustees for such crumbs of favor as may now and then be thrown in their direction. In general they feel keenly that something is amiss, but fail to analyze the situation and locate the trouble. Yet the situation is not difficult of analysis. The key to it lies in the fact that the college is governed by men who lack the technical experience necessary to govern it well, and the faculty, who possess this technical experience, are barred from any effective share in its management.

The president makes a sincere effort to make a fair and equitable adjustment of the budget to the needs of the departments, but he fails, and that for a number of reasons. In the first place, he lacks the technical knowledge necessary to an understanding of the needs of the departments. In the second place, he is under the influence of the trustees with their passion for expansion and inflation; and he is continually trying to make a big showing by putting the funds that should go to the strengthening of existing departments into the creation of new ones, or into advertising. Thus the older departments are deprived of needed equipment (the students of course being the ultimate sufferers) and salaries are kept below the efficiency level. In the third place he fails because he enjoys too large a measure of irresponsible power. It is the fashion nowadays to compare the college to an indus-

trial plant, and the president to a factory superintendent. But there is this difference: The superintendent of the plow factory in our town can make a plow. He knows the details of construction in every department of his factory, has actually done the work himself, and can do it to-day if necessary better than any of his men. On the other hand, the college president knows far less about any given subject than does the professor who is set to teach that subject. He has no first-hand knowledge of the needs of any department. The factory superintendent is an expert directing the efforts of those less skilled than himself. The college president is a tyro directing a body of experts. His very ignorance makes it unsafe to place the power of official life and death in his hands.

As for the trustees, there can be no doubt that they are earnestly loyal to the college and devoted to its interests, and their own careers attest them good business men; yet the business management of our college is notoriously poor. College property that might have been made to return an excellent rental has been allowed to lie unproductive for years, and finally sold off bit by bit to pay running expenses; debt has been recklessly incurred; and there has never been any settled or consistent financial policy. The board, indeed, is too big a body to work well. It consists of twenty-four members when five would be a much more effective body. But the principal difficulty lies in the fact that the time of board meetings is taken up in the consideration of a multitude of problems all of which belong by right to the province of the faculty, and too little attention is given to the matter of finance. Briefly stated, our board fails because it does not concentrate its time and energy exclusively on the one thing for which it exists, namely, the providing of ways and means.

It is easier to criticize an existing system than to work out the details of a new and better one; yet the diagnosis just given suggests the remedy. The number of trustees should be reduced to five or six—of whom the president of the college might well be one *ex officio*—and their activities should be limited strictly to the investment of college funds, the raising of new funds, and the collection of rents and interest. After setting aside enough of the latter to meet overhead charges in the way of repairs, care of buildings and grounds, etc., they should place the balance with the college treasurer to be paid over to the various departments in accordance with a budget to be worked out by the faculty. The president should be the chairman of the faculty and its public representative, and should have a veto on all acts of the faculty—a veto which the faculty might override by a two thirds vote. The faculty should have complete and absolute jurisdiction over all the internal affairs of the college, and over the budget, subject only to the veto of the president; they should elect all teachers, subject to the approval of the president, and should when occasion demands elect the president,

subject to the approval of the trustees. Finally, no member of the teaching force should be liable to discharge except after the filing of formal charges of impeachment, and a trial before the entire faculty, and the concurrence of the president and two thirds of the faculty in sustaining the charges alleged. Some such system as this, arranged to place every responsibility on the shoulders of those best equipped to meet it, and safeguarding against the misuse of power by an adequate system of checks and balances, would eliminate most of the evils incident to the present system of American college organization.

It may be objected that the budget would be a fruitful source of faculty discord. Some discord might, indeed, exist, but it is a fair question whether discord is not preferable to intrigue. Were it not better for a professor to go into faculty meeting and fight for the weal of his department openly, than to enter a private office and lobby for it secretly. In colleges, as in politics, publicity is a strong incentive to decency. The present system is one of secrecy, intrigue and deceit. The president, who holds the key to the situation, lacks the necessary special knowledge of the departments and their needs, and the securing of funds by the various professors becomes largely a competitive test in the matter of sycophancy. It were better to have all such matters threshed out in open meeting, with the data in question before the faculty. In the end its decisions would be fair and just. Here, as elsewhere, the principle of democracy will work if given half a chance.

Finally, to the charge that the proposition here offered is too radical, let us make answer by advising all doubters to study carefully the organization of the colleges of Oxford and the universities of Germany.

When one college shall have adopted the plan here suggested of transferring to the faculty the functions that are rightfully and naturally theirs, and limiting both trustees and president to their natural functions, a new and brighter era will have begun in the history of American education. The standard of collegiate instruction will at once rise many degrees, the college teacher will become a more useful member of society, as will also the college president, harmony instead of discord will reign among the three branches of the college government, and all three will be in a position to make a united and effective attack on the educational problems that are calling for solution. For when one institution shall have changed, others will soon follow, and in time our entire college system will re-form itself in accordance with the dictates of true wisdom, and along the lines of true democracy.

LABOR AND CAPITAL

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THE manual worker is not left in ignorance respecting his rights, his wrongs and his importance. In season and out of season he is taught that the world owes every man a living and that he should receive wages enough to support his family according to the American standard; that his labor makes value and that his share of the profits is withheld; that capital, all-powerful, is consumed with passion to enslave helpless labor; that he can secure his rights only by compulsion, since the interests of capital are antagonistic to those of labor. These matters deserve consideration.

The world, that is, the community, owes no man a living; it did not bring any man into existence and it is under no obligation to support the children of heedless parents. One must emphasize this truism, because there is a rapidly growing tendency to believe that poverty and vice are due to the rapacity of employers and to insist on the responsibility of the community, *en masse,* for continuance of the evil conditions. During a so-called investigation by a commission of the Illinois Senate, an official of the Illinois Steel Company was asked to tell what he regarded as a fair living wage for a man with a wife and daughter. At a hearing before a Massachusetts commission it was shown that the wages paid are so small that one employee, in order to support himself, his wife and their eight children, was compelled to do outside work—and the heartless corporation was duly flayed in headlines. But it must be evident to any thoughtful man that wife and children can not be considered in connection with the relations of wage-earner and wage-payer. The only question concerns the worth of the man's services. Introduction of other matters would so increase the uncertainty of business affairs as to make them little better than a lottery. If a man's services are not worth enough to secure wages which would support a family, he should not marry. He may not complain because the community is unwilling to have him gratify his desires at its expense.

The wage in shops and factories is said to be so small that women are driven to prostitution; one is told that, in each year, 200,000 women in our land are compelled to sell their bodies to procure the necessaries of life, and that each year sees 700,000 children perish because their parents have insufficient nourishment. But the voices, which rise in bitter outcry against this awful condition, do not rise in protest against encouragement of unrestricted reproduction among the wretched or against the wide open door which increases the population annually by

a net half million of, in great part, poverty-stricken immigrants—and this in face of the fact that our country is no longer able to provide work for those already here. If it be true that the alleged number of children die because they or their parents have insufficient nourishment, one must concede that their deaths are a blessing to themselves and to the community. Such children should not have been born. But the assertions are *a priori,* they can not be proved and are closely related to the other assertion that poverty is *the* cause, not merely *a* cause of crime. The statement of an abandoned woman before a State Commission is accepted as final, despite the counter assertion of the associated social workers, whose close relations with the impoverished classes should make their statements authoritative. But the slanderous statement is spread broadcast and wage-earning women are viewed with suspicion.

It may well be that not a low wage, but a wage too low to gratify vanity or the desire for luxuries, may be the determining cause in a great proportion of cases. Sexual desire is the strongest natural appetite in every normal young man or woman. If there be a deep-seated moral sense, the wage will make no difference. If there be no moral sense, the wage is unimportant. So long as the chief deterrent from gratification of the desire is the fear of inconvenience and social disgrace, yielding to temptation will be dependent on the danger of exposure. Unquestionably, the majority of fallen women come from the poorer classes, because those classes are by far the most numerous; but a very considerable proportion have come from among those whose wages are far from low, while the record of divorce courts make very clear that even the possession of wealth can not prevent women from straying. This question of morals in women employees answers well as a slogan in attacks upon wage-payers, but it appears to sink into insignificance when it involves the rights of wage-earners as against the wage-payer. A telegram from Everett, Washington, dated October 23, of last year and published in the New York papers, gives the illustration. The manager of a telephone company, appearing before the State Industrial Commission, held that employers should weed out from their service all immoral girls and women. But two women members of the commission maintained that employers should not concern themselves about the morality or immorality of women employees, provided these perform their tasks efficiently; these commissioners insisted that the employer has no right to exercise any control over the conduct of employees outside of working hours.

The demand that all should be able to live according to the "American" standard, whatever that may mean, is coupled with the assertion that wages have not kept pace with the increased cost of living. Tables of comparative prices are published in the daily papers, which prove that the cost of food has increased incredibly within a decade or two. It is well understood that one can prove almost anything by means of

statistics and these tables are illustrative. Some of them are as absurd as would be tables to prove increase in cost of living by comparing the price of diaphanous calico in 1858 with that of the finest cambric muslin in 1913. The writer has lived in New York city during almost three quarters of a century and he knows that, whatever may be the conditions elsewhere, prices of the essential articles of food, with few exceptions, show comparatively little increase during the last fifty years, while some show a marvelous decrease—material of the same quality being compared throughout. Beef, such as nearly all New Yorkers ate sixty years ago, can be purchased at hundreds of large shops at barely 20 per cent. higher price; flour, grade for grade, has not risen in price, while the great fluctuations in price of the olden time are unknown—in 1854 or 1855 the writer paid twelve dollars for a barrel of family flour for his father; eggs, grade for grade, are, thanks to cold storage, little higher during the winter months than they were many years ago; while refined sugar costs to-day little more than was charged for a light brown sugar in 1858. Butter and hog products have increased in cost and are likely to continue increasing until ruled off the list of foods. The growth of urban population has destroyed the butter industry, as sale of milk is more profitable and less burdensome. In former times, when corn was worth only a few cents per bushel, western farmers had their choice between using it as fuel or converting it into pork. But corn is worth now from 50 to 70 cents per bushel, according to the crop, and it can not be converted into pork except at a loss. Pork will disappear as a food staple and butter will be replaced by the more wholesome oleomargarine products. Within our large cities, an anomalous condition exists in the price of vegetables. Wholesale prices have not increased, indeed in many cases, they have decreased greatly; yet because of archaic methods of distribution, the retail cost is greater. But this does not concern the general question.

The stability of prices of the food staples, in spite of increasing demand, is due to several causes, of which only three need be noted; the consolidation of continuous transportation lines, which has made possible the extraordinary low freight rates in this country; the consolidation and localization of manufacturing interests, which has increased available capital and has led to introduction of improved methods; the ingenuity of inventors, which has made unnecessary a vast quantity of unskilled, even of skilled labor. Our flour is from Dakota wheat ground in Minneapolis and our beef is from western cattle slaughtered in Chicago, yet the prices are, at most, little higher than those paid sixty years ago for flour brought by water from Rochester and Richmond, or for beef from Ohio and New York.

But in some other directions, where the inventor's work has not kept pace with expansion or where trade-union influence has prevented full utilization, the effect of increased wages is only too manifest; the

mechanic has himself to blame for the untoward condition. Compared with 1858, a day's work means fewer hours and greatly increased wages. One illustration suffices. Building is much more expensive when bricklayers receive about 6 dollars for 8 hours of work than it was when they received 2 dollars for 10 hours' work. The increased cost of living in large cities is due very largely to increased wages for decreased hours of work. If one doubt this relation between wages and prices, he needs only comparison of the cost of pig iron and of ready made clothing in 1897 and 1901, the difference being due almost wholly to wage-increase.

The cost of living has increased out of proportion to the wages, but only because the mode of living has changed and the requirements are greater. The clothing of fifty years ago would not satisfy the people of our day. The clerk must ape the man who has twice his wage. The workingman demands luxuries for his table, which the well-to-do man of sixty years ago never thought of buying. One is asked indignantly, Has not the poor man a right to these things? Certainly, if he can afford to pay for them, just as every man has a right to an automobile and chauffeur, if he can afford to pay for them; but no man, rich or poor, has the right to expend so much of his income on things, not necessary, that, when times of depression come, he will have nothing left and must become a burden to the more provident members of the community. The complaint is the same throughout the scale; it is not confined to the "poor" but is common to all; the man with two dollars a day is embittered as he considers the luxury of the man with five dollars; the man with ten thousand dollars a year is unhappy because, in his limited condition, he can not make so grand a show as does the man with twice or five times as much. It is impossible ever to reach the "living wage," because desires increase with the income and poverty is always present. Men's minds dwell almost wholly on what they have not; too few are willing to recognize the abundant blessings which they possess.

Labor certainly creates value and it is entitled to a generous reward; but this doctrine, as defined by labor unions, is not exact, since they lay the chief emphasis on manual labor. Yet they do not ignore the superiority of mental labor. The plasterer, whose work requires much natural as well as acquired skill, would be indignant at a suggestion that a hod-carrier should receive wages equal to his own. Unskilled labor is merely animated machinery for rough work and adds very little value to the final product. It is utilized because abundant and low in price; as soon as it demands an excessive wage, it is displaced by machinery. Skilled labor, combining muscular and mental effort, increases the value in proportion to the mental expenditure; but mental labor, involving no muscular exertion, adds most of all, it is the coordinating, creating power without which the others would be helpless. One E. H. Harriman is of more lasting service to a nation than would be one million of unskilled laborers; without a Harriman they would be a menace. The

complaint by the lower grades of workers against the reward paid to those in the higher grades is as absurd as would be a complaint by raw Muscovado sugar because refined sugar brings a higher price.

The asserted power of capital is little better than a nightmare. There can be no federation of capital comparable with the existing federation of labor. The acquirement of capital, that is the saving of a part of one's income or wages, demands much personal independence and self-control, an individuality which makes impossible such slave-like obedience as prevails in labor unions. A monopoly, except through ownership of patents, can not exist in this land. The field for capital is wide open and if any man or corporation prove that a business is profitable, competitors appear quickly, demanding a share. The dwindling proportion of trade controlled by the United States Steel Company, by the American Sugar Refining Company as well as the bitter competition between manufacturers of tobacco amply confirm this statement. Capital constantly combines against capital. The fruit raisers of California unite against the transportation companies to secure unremunerative freight rates, as though the railroads are to blame because the orange and lemon groves are 4,000 miles from the Atlantic seaboard. The tobacco farmers of Kentucky combine against the manufacturers to increase the price of raw materials and enforce their mandates after the most approved trade-union methods; makers of heavy, bulky goods, in order to secure space cheaply, put their factories in out of the way places, but they denounce the transportation companies as robbers because these desire a fair remuneration for special construction and service. The sluggish capitalist, as shopkeeper or manufacturer, rails against his energetic competitor and finds prompt encouragement from politicians, who would tax the efficient man out of business and would leave the community at the mercy of inefficient managers, wedded to antique and expensive methods of production.

On the other hand, combination of labor is no mere possibility; it is an accomplished fact. Labor unions, though controlling only a small proportion of the hand-workers, have succeeded by compact organization in terrorizing office seekers and office lovers, so that legislative bodies grant their demands with little apparent reluctance—and this in spite of the fact that, in some portions of the country, the membership of great unions is largely alien. Compensation laws are enacted freely and are wholly against the "capitalist," who pays the wages to workingmen and the construction placed upon these laws almost invariably favors the employee. Such laws, unquestionably, have solid foundation in justice. An employer must have care for his servants who, too often, are helpless against careless fellow-workers. The employer should enforce discipline and should discharge at once the negligent, incompetent or disobedient employee as a source of danger to persons as well as to property. If he retain such employees, he is himself negligent and should pay the full

penalty in case of disaster. No one may complain against this; it is absolutely just. But at once the question arises, who is the employer? The prevailing impression is that those who pay the wages are the employers and compensation laws accord with that belief. The conception was correct enough fifty years ago, but in most industries it is very far from correct now.

In what may be termed unionized industries, the wage-payer is an employer in only a very limited sense. The trade union is the employer, the only employer. The chief strife between capital and the unions concerns this one matter. The many recent strikes in non-unionized industries were not to secure higher wages or shorter hours, but to secure recognition of the unions. Betterment of the workmen's conditions was always mentioned, but that was a secondary matter. The result of such recognition has always been transfer of control from the wage-payer to the union officials. The owners of industrial concerns assume all risks while others control the workers and the methods. Railroads are denounced in congress, in legislatures and in the press because they invite disaster by retaining incompetent servants. Mining and manufacturing companies receive similar treatment. Yet nothing could be more unreasonable. Commercial enterprises are undertaken to secure a fair return on the investment and competition is so severe that the margin of profit is narrow. Owners and managers have no desire to invite disaster and to reduce dividends; but they are helpless in unionized industries. The unions permit employment of only their own members; they determine the rate of wages, the hours of work, the manner of working and, in some cases, even the materials to be used. They demand oversight of discipline and the right to decide whether or not an employee should be dismissed. A superintendent, determined that men must give honest service for the wages received, is denounced as tyrannical and his removal is called for with a strike as the penalty for refusal. In all essential matters, the trade union is the employer, with power to stop work or to begin it again. It regards itself as actual owner of the property and the owner of record is to be tolerated only so long as he obeys the rules. It justifies seizure of the property during a strike; it justifies violence, destruction of property, assassination and resistance to officers of the law in case its demands are refused; it denounces as murderers the men who defend their property against an attacking mob; and it proclaims that its crimes are political, not moral, because the strife is a warfare for human rights.

Labor unions should be incorporated that they may be made responsible as the real employers, as dealers in human labor. Under existing conditions, agreements can be enforced against the wage-payers, but not against unions. When the law has recognized that the union is the employer, disasters on railroads, in factories and in mines will be reduced to the minimum. Reckless engineers, careless switchmen and

negligent shopmen will find little mercy at the hands of union officers; miners will see to it that props are put in place and that covers are not removed from lamps; incompetent workmen will be weeded out from the factories and the loss through defective wares will be small. Leaders will not be too earnest in breeding discontent or in urging strikes on frivolous grounds. But those who guide union affairs oppose incorporation; that means stability in conditions, steady work for workmen, no waste of savings during enforced idleness and consequently the destruction of the leaders.

The state, under such conditions, would be compelled to distinguish sharply the several duties of the wage-payer and the employer. Serious responsibilities would still rest upon the owners of property in which men are employed. There would remain to them the duty of protecting workers against accidents due to imperfect machinery or appliances. Yet even here the complexity would remain and strife would not cease. It would appear that the only solution of the problem may be in placing control wholly in the hand of wage-payers, as in non-unionized industries.

The professions of the trade unions are at variance with their practise. They pretend that they are warring for human rights, but they deny the natural right of all men to work and endeavor to limit it to their own members; they deny the right to earn, by fixing a common wage for competent and incompetent, for faithful and unfaithful men alike; they cry for uplift of the working classes, but they resist all efforts to close the cleft between "classes" and "masses," insisting that it remain a bridgeless chasm; an "employer" of labor can not gain or retain membership in a union, because the several interests of labor and capital are antagonistic. When Sir Christopher Furniss offered to his striking workmen the opportunity to purchase his shipbuilding plant on easy terms or to become partners on a profit-sharing basis, the union officials rejected both proposals on the grounds that acceptance of the first would create only another class of capitalists and that acceptance of the second would develop a class of selfish workmen, who would not try to help the "under dog." The plan of the United States Steel Company to offer stock below market rate to the more efficient workmen was denounced as a base trick to bind men to their employers by selfish interest. Workingmen everywhere are taught to look with suspicion on all efforts of employers to encourage thrift. It is impossible to believe that the heads of labor unions have at heart the interests even of their own followers. Enforced idleness during frivolous or sympathetic strikes, lodge dues, strike assessments, testimonials and other contrivances, equally ingenious and successful, certainly prevent too rapid accumulation of savings and remove all danger that the men will become financially independent of their owners. Yet these owners never weary

of picturing to the workingman the miseries of his condition; one might imagine that medieval conditions exist everywhere, whereas they exist only among the peons of the trade unions. Cicero was unable to understand how one soothsayer could look in the face of another without laughing. He would be more puzzled to-day if he should hear a labor leader telling his serfs that capital has made it impossible for a poor man to rise above his caste—and this in New York city, where a great proportion of the wealthy men have risen from poverty and a very great part of the real estate is controlled by men who reached this country almost penniless less than 30 years ago. The savings bank deposits in the anthracite region and in the copper region of Michigan prove that the "awful misery" did not exist when the men were at work. These savings have been referred to boastfully as the "backbone of the strike."

The selfishness of unions proves the hollowness of their pretence that the warfare is for the rights of humanity. Not only do they attempt to prevent all except their own members from gaining a livelihood, but they also do not hesitate to incommode the whole community, rich and poor alike, in order to hasten success of a strike. It matters not how insignificant the matter at issue may be, the fact that it is an issue makes it so important that destruction of the community would be preferable to defeat of the organized minority. One need not occupy space by detailed illustration. The numerous trolley strikes, ordered at hours when most inconvenience and suffering may be caused; the recent strike of railway engineers in northern England, whereby a great region was threatened with starvation, because the company had suspended a tippling engineer; the recent strike vote on a New England road because the company insisted that fitness should be considered in assigning engineers to important trains; and the strike for similar reasons on the Southern Pacific road suffice. The list might be increased indefinitely, showing indifference to interests of workers who do not belong to the union army—even of those who do belong to that army, but not to the disturbing regiment. The boast, "for the rights of humanity" means for the right of union humanity. Mr. John Mitchell is reported to have said at a convention of labor leaders, that the condition of wages is better than ever before, but still he would ask for more. If a 25 per cent. advance were granted, he would demand yet more. If an eight-hour day were secured for all, he would struggle for a seven-hour day. All this, of course, for unionists. Members of unions are said to number about 2,000,000 in this country; they are to thrive at the expense of the vast majority, who must pay them high wage for a short day. Many are puzzled to explain why trade union workers should have a short day when almost all others have a long day, although the labor in most of the trades, which are unionized, is less exhausting; but the explanation is simple; the union, like the highwayman, possesses power to enforce its demands. There is no laborer save the "horny-handed son

of toil"; others exist to be exploited in his strife against the natural law of work.

Labor unions and their defenders justify the use of violence because without it they could not succeed. The assumptions are that labor and society are at war, that the interests are irreconcilable and that demands by labor leaders are always just. McNamara at Los Angeles saw no moral turpitude in arson and murder, because he fought for a principle. The unions evidently agreed with him for they expended a vast sum in his defense. Thirty-eight men were convicted in Indianapolis of complicity in his and similar crimes, but the union approved their work and re-elected the convicts to their offices. The daily papers report almost daily cases of murder and arson in localities where strikes have been ordered. Labor unions defy the law but are ever ready to demand its protection; their principles are no better than those of the India Thugs, who practised robbery and murder in the name of the goddess Cali.

The cruel disregard of other's rights is not born of folly; the union men know that a great part of the community sympathizes with them. Propagation of their doctrines has not been ineffective. There is a general disaffection against those who have achieved success; it matters not what kind of success, the thing itself is a crime. The brutal rapacity of "capitalists" is a welcome theme and no charge is too absurd to be accepted as true. If it be proved false, retraction is made grudgingly with the reflection that the old wolf has escaped this time, but he ought to have been hanged long ago. It is still an article of faith in many quarters, even outside of those inhabited by peoples alien to our mode of thought and to our language, that the panic of 1907 was contrived deliberately by capitalists of New York city, the ground for the belief being, apparently, that they can bring on a panic if they choose. The worst charge that can be brought against a man is that he is rich or against a combination of men, that it is a corporation. The most serious feature of present conditions is the blind, inconsiderate hostility to "capital" manifested by legislators, who are clearly ignorant of what the term means. There is reason to suppose that the average business man is no more and no less honest than the average of mankind or of labor leaders; but his lack of integrity is less dangerous than that of a labor leader, because his interest requires that the community be prosperous, whereas the labor leader is indifferent to the community's interests; he is concerned only with his *imperium in imperio.*

The propaganda has been so successful that in every contest between wage-payers and unions the popular presumption is against the former. During trolley strikes, indignant sufferers vent their wrath upon the company which refuses to grant the petty demands; when trains or trolley-cars must be withdrawn because of half-hearted protection by the authorities, a cry for repeal of the franchise is raised. A public utility corporation seems to have no rights which the law is

bound to respect; it may not share in the general prosperity; even high officials appear to think it virtuous to over-reach such corporations. And all this because they have received certain privileges from the state, which are of inestimable value, while the services rendered in return are wholly undeserving of consideration. The popular antipathy to "big business" has become almost a mania and a great part of the community trembles at the concentration of the "money power" in the hands of a few score of men—though why there should be such terror on account of concentration of the money power and no terror because of concentration of the labor power in still fewer hands is difficult to understand. Laws against mere bigness have been enacted as readily as though it were a crime like burglary. The case of the Harvester Company is in point. The Missouri judge recognized that the whole course of that company had been commendable and to the advantage of the community, but, under the statute, he was compelled to impose a heavy fine because, by acquiring practical control of the market, it had become able, if so disposed, to inflict injury. That the American Sugar Refining Company has reduced the cost of sugar by 50 per cent. and that it is satisfied with a gross profit of less than half a cent per pound is nothing; the concern is too big. That for every dollar of gain secured by the Standard Oil Company the community has gained many hundreds through the reduction of illuminating oil to one sixth of the price 40 years ago is nothing; that most of the profit gained by that company has come from utilization of what was regarded burdensome waste material is nothing; the company is too big and makes too much money. The stupendous service rendered to the country by the United States Steel Company by prevention of panics and depressions is nothing; it is too big. Attacks on these organizations by government officials win great applause, in spite of the fact that so-called "trust-made" products are almost the only ones which have decreased in price—although the great companies pay high wages and their workmen have steady work, because trade unions can not gain a foothold to impoverish the wage-earner by strikes and compulsory idleness.

The confusion of ideas respecting the relations of labor and capital is perplexing; the terms are not used in the ordinary sense throughout. Combinations of transportation or manufacturing companies are taken to be, in themselves, evidence of conspiracy in restraint of trade; but positive conspiracy in restraint of trade by organizations, avowedly formed for that purpose, is highly proper on the part of agriculturists and labor men; and the authorities must not interfere. Tobacco raisers in Kentucky may combine to secure higher prices for their products and "night riders" may burn the property of those who refuse to join the conspiracy; labor combinations may struggle to destroy competition with their members, may attack, even murder those who refuse to sub-

mit to their dictation, and they may destroy the property of those from whom they have been receiving wages; cotton planters in the south may combine to force higher prices for their commodity, even though they resort to violence that competition may be prevented. All such combinations are but exercise of natural rights, with which the law should not interfere. But when manufacturers or transportation companies combine to stop waste or ruinous folly in competition, they must be checked at once as threatening the community's prosperity.

This confusion of ideas is not confined to the "unthinking"; it is found among those whose prominence in public affairs is a fair presumption in favor of belief that they are thinking men. Organizations engaged in great industries have retained representatives at Washington as well as at other capitals in order to protect their interests by opposing injurious legislation. There is no doubt that they have endeavored to compass the defeat of politicians who opposed them and they have expended large sums of money in printing and postage to influence public opinion—they do not "admit" this: on the contrary, they assert it unhesitatingly and justify their course. Newspapers and politicians profess to be shocked by such avowals and it is said that some members of an investigating committee were stunned by the shamelessness of the "capitalists." One's sympathy goes out to those innocents. Yet such efforts are within the rights, indeed are within the duties of every citizen; certainly they are in every sense as proper for "capitalists" as is the conduct of taxpayers' associations, philanthropists or labor unions when they do the same thing. Nevertheless, it would appear that the labor unions were aiding the uplift of humanity when they endeavored to prevent reelection of Mr. Cannon, who had treated them with contempt, whereas the National Manufacturers' Association was endangering the Republic's stability by its efforts in his behalf. It was thought to be pernicious lobbying when the Hawaiian planters struggled for retention of tariff on raw sugar while the Federal Sugar Company was thought deserving of credit because it sought removal of that tariff; among the many protests against lobbies few were heard against the labor lobby, which has been denounced as the most insidious of all. Senator Lea summed up the matter clearly when he stated that when a visitor disagrees with a congressman's opinions, he is a lobbyist; if he agree, he is an expert. Those who have followed closely the discussions in congress during recent years must be convinced that too many members are afflicted with the omniscience of ignorance and that they are sadly in need of information on nearly all subjects except the local interests of their districts.

But one may ask, how can such conditions exist and how is it possible that men bearing the responsibility of public office can yield to influences so injurious to the common weal? The writer is no mind-

reader; it is not for him to impute improper motives in any case. He may note only the facts which are familiar to all; others may make such inferences as they will. A bill, containing a clause exempting labor unions and agricultural combinations from prosecution under the Sherman law, as far as was possible under such legislation, was presented to the President, not against his will, and was signed by him; the Secretary of Labor is proud of his success in unionizing a Maryland coal area that a strike might be declared in sympathy with a strike in Pennsylvania, more than 200 miles away; the United States Printing Office is in the hands of a prominent labor leader. Wholly similar conditions prevail in several of our great states. Congress and legislatures, at the behest of labor unions, enact laws which are prejudicial to the public interests and to the great industrial systems of the land. The whole sympathy of authorities seems to be with the "under dog" of labor. Interference with strikers and their sympathizers rarely begins until destruction of life and property is well advanced. Even then the person of strikers and their sympathizers is strangely sacred; the first volleys of the soldiery must be directed upward, though the volleys from the mob are direct; the person of the guardian of the law is unimportant, but if a rioter be killed, the officer who ordered the volley is in very great danger of criminal process. Protection is given grudgingly to wage-payers, who attempt to conduct their business in opposition to the striking workmen who have abandoned their jobs; introduction of men willing to work seems to be regarded as a crime. The strike of express-wagon drivers in New York city, the recent trolley strike in Indianapolis and that on the Boston Elevated road illustrate the conditions which should bring a blush of shame to the cheek of every patriotic American.

Organized labor, as well said by Governor Brown, of Georgia, is "the most wide-spread and exacting trust in America—levying a toll on all the other elements of our citizenship." Alone of all the great combinations, it can not gain by lowering the price of its wares: it strives to secure a monopoly, that the rest of the community must purchase its wares at an exorbitant price.

These new tribunes of the people, fomenting discontent and class hatred, are sowing seeds which, if permitted to develop, will bring about the destruction of this republic. The time has passed for the comforting reflection that our institutions are secure and that education will prove the cure-all in this "melting-pot of the nations." There is no longer a melting-pot, the elements are incompatible, they can not fuse together. Thoughtful men must unite at once to secure equality of all men before the law, in which alone security for our institutions can be found.

THE STRUGGLE FOR EQUALITY IN THE UNITED STATES
VI

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The Courts and Property. III

The framers of the constitution were fearful of democracy and entertained serious misgivings concerning the essential goodness of man. In theology, many of them accepted the doctrine of original sin, total depravity, infant damnation and the final perseverance of the saints. In politics, they distrusted the masses, favored a restricted suffrage, provided an electoral college for the choice of president, left the election of United States senators to the legislatures of the several states, contrived the system of checks and balances and established an appointive judiciary with power to set aside an act of Congress. The constitution was the work of the "solid, conservative, commercial and financial interests of the country" who feared legislative tyranny and whose solicitude never lost sight of the safety of property. For a long time, however, the guaranties of property in the constitution were never seriously put to the test. The one noteworthy exception was property in slaves which the constitution failed to protect. Until recently the ownership of property was widely diffused, and because of the abundance of fertile land the man without property to-day stood an excellent chance of becoming an owner to-morrow. There was no wage-earning class destined to remain such to the end of its life. For a time the scarcity of men willing to work for hire handicapped the development of manufactures. It has not been the distinctive features of our form of government so much as our environment that has given us peace with plenty.

It does not follow consequently that our governmental and economic systems, under the conditions which obtain to-day, are proof against socialism. The institution of private property depends upon the general consensus of opinion which varies from age to age. It is a common error to suppose that whatever is always will be. Take the right of a man to interfere with the business of another by normal competition, by way of illustration. This is regarded as a matter of course to-day, but there was a time when the right to engage in a given trade was restricted to the members of a certain guild, and a man was not at liberty to enter any pursuit be might elect. The individual's position in the social order

was determined by the status into which he happened to be born and not by competition. Accordingly, the courts in place of upholding the right of competition as at present were once inclined to look upon it with disfavor.[32] Likewise, property rights are no more absolute than is the right of competition. Slave property, once nation-wide, became sectional and then disappeared altogether. Property in general depends as much upon considerations of social utility as property in slaves. For a long time it was restricted to movables. At first it included only weapons and ornaments. Gradually it came to include domestic animals. The ownership of land was vested in the community and not in private hands until comparatively recent times. The powers and franchises granted corporations are wholly optional with the several states, and depend upon considerations of social expediency. But for the social will embodied in positive law, there would be no such thing as theft.

At the present time property rights are being modified in various directions. There is a strong tendency to municipalize or nationalize certain industries. In Ireland, the property rights of the large landowners have been abridged by Parliament. Railway and other labor organizations that occupy a strategic position are altering the distribution of the social income and are establishing a sort of joint proprietorship. This is the effect of "full crew bills." According to the committee of railway managers, the demands of the railway employees on the eastern roads at the present time for an advance of wages are equivalent to putting the income of three hundred and forty millions at five per cent. ahead of the first mortage bonds of the roads.[33] The modification of the liability of employers at common law, the enactment of workingmen's compensation acts and more ample provision for playgrounds, art, music and education by taxation and private benevolence point to the growth of collective property. The social obligations resting upon private property are increasing. The abridgment of property rights is reflected in the lighter punishments provided for offenses against property. Imprisonment for debt has been abolished. The branding of thieves and vagabonds has been discarded. Capital punishment for crimes against property no longer exists. Many punishments which appear cruel and unusual in the light of to-day did not appear so at all to our forefathers. As humanitarian considerations have gained ground, private property has lost something of the sanctity in which it was once held.

It is remarkable how quickly even the staunchest defenders of property sometimes face about and demand an abridgment of property rights. All that is needed is some event that brings out clearly the opposition between private and public interests. A strike that ties up

[32] Bruce Wyman, "Control of the Market," pp. 11–12.

[33] *The Commercial and Financial Chronicle*, July 12, 1913, p. 76.

the steam roads of the country, or the street railway service of a city, may turn out to be such an event. The anthracite coal strike undoubtedly was. No one would probably accuse so "safe and sane" an organ as *The New York Tribune* of socialistic learnings, and yet this paper remarked:

> The old doctrine that a man may do what he will with his own worked well enough when the life of the community was not dependent on what he did own, but some way or other it does not fit the case when a whole community is under one control. It did not seriously matter if one mine was shut down and its product cut off. The community could allow the owner to say it was his, and his use of it did not concern them. But when all the coal mines are subject to one will, the way that will works is of profound interest to those dependent on it. The mines are at law unquestionably private property. Nobody can go into court and get relief because the mines do not produce the coal he needs. But there is a moral trust—even kings now admit that, even though they rule by divine right, they hold a trust for their people. Prerogative and title are with the operators, but the people must have coal, and if the operators forget the moral obligations attached to their property-holding they will force the substitution of legal for moral obligation in some form or other.[34]

If the public mind veers strongly toward socialism, there are at least three ways by which it may attain its goal. First, private property can be more heavily taxed and more heavily subjected to the police power of the state. All of the machinery required for these purposes already exists. No constitutional change is necessary. Private property is held subject to the right of the state to tax. In addition, in such cities as New York, the building department supervises all structural changes or defects in buildings; the tenement-house department regulates the number of windows required for light and air and all alterations in houses occupied by more than three families, and if its orders are not complied with this department has power to vacate property and lock it up; the fire-department prevention bureau has charge of such matters as fire escapes; the board of health sees that certain sanitary requirements are complied with; the highway department requires abutting owners to keep their sidewalks in repair; the state factory inspectors have supervision of establishments where one or more men are employed, and the street-cleaning department looks after such things as garbage receptacles. An increase in the scrutiny of the public eye in each of these directions is easily conceivable. There is no hard and fast line between "taxation, reasonable regulation and fair payment," on the one hand and confiscation, on the other. The difference is a matter of degree and of opinion.

Secondly, a much more important gateway to socialism stands wide open, namely, the regulation of bequest and inheritance, neither of which is a property right under the federal and state constitutions. So

[34] Quoted by *The Outlook*, August 30, 1902, p. 1035.

long as public opinion favors private property, laws governing bequest and inheritance similar to those which exist at present will be continued in force. But if public opinion ever turns in disgust from the existing economic system, convinced of the practicability as well as of the desirability of socialism, a change in the laws governing the descent of property will be one of the easiest methods of approach.

In the third place, the position of the federal courts is not impregnable. Save only the Supreme Court, Congress has power to abolish them. This was actually done in 1801 in the case of the "midnight judges." More recently the existence of the Commerce Court has been threatened. There is no way, moreover, of compelling a recalcitrant Congress to make appropriations for the federal courts, and if so disposed the President by failing to appoint or the Senate to confirm could permit even the Supreme Court to die a peaceful death. Jefferson, Jackson and Lincoln showed that a Supreme Court decision is not binding on a coordinate department of the government. The constitution expressly makes the appellate jurisdiction of the Supreme Court subject to such exceptions and regulations as Congress shall make. On one occasion Congress limited the appellate jurisdiction of the court with a view to preventing it from declaring an act of Congress unconstitutional. This action was upheld by the court itself.[35] It is well known also that Congress can pack the court by increasing its membership. Professor Goodnow aptly remarks "that almost all of the great powers which the federal courts possess are theirs only because of the fact that their exercise of these powers has as a whole been satisfactory to the people of the United States."[36]

IV

The main reliance of property owners does not lie in constitutions and courts, but in not violating the sense of fair play. The desire for property is well-nigh universal, and, so long as a fair and open field is maintained, the sense of injustice will have little chance to take root, and the army of property owners, both actual and potential, together with their natural allies among those without property, will be too numerous to be dispossessed. The danger to property does not lie so much in the minds of wily agitators, in the ignorance or depravity of the common man, or in the envy which the poor bear toward the rich as in closing the door of opportunity to the struggling and aspiring masses. So long as a man could homestead a piece of land, there was no social problem such as exists to-day. No self-respecting class whose necessities condemn it to a life of barely requited toil can be expected to rest content without at least the hope of something better. There is no

[35] Goodnow, *op. cit.*, p. 345.
[36] *Ibid.*, pp. 343–344.

better way to safeguard property than to give every man a fair start and an even chance in life. No class can so ill afford to disregard the forms of law as the owners of property. To throw labor agitators into jail or to railroad them to the penitentiary on trumped up charges, to seize their persons and deport them from the community by an unlawful exercise of force, or to interfere unwarrantably in any way with their freedom of speech, is undisguised anarchy. Those property owners who make undue exactions, who entrench themselves in positions of privilege, who use the state for their own aggrandizement and for the exploitation of the weak, or who stand out against much needed reforms, are among the worst enemies of their class.

The sooner employers abandon all pretensions to being a superior class appointed by Providence to look after the interests of labor, the better it will be for the property-owning class.

The rights and interests of the laboring man will be protected and cared for, not by labor agitators, but by the Christian men to whom God in his infinite wisdom has given control of the property of the country.

These are the words of the leading spokesman of the coal operators during the anthracite strike of 1902. They betray a feudalistic frame of mind, and they did more to undermine the right of private property than the numerous acts of violence committed by lawless strikers in the coal fields. It is nothing less than amazing that so astute a business man should have made so glaring a mistake. The divine right of property to rule is no less objectionable than is the divine right of kings. It ill becomes a spokesman of capital to uphold a monopoly in a necessary of life while refusing to treat with a combination of labor, or to lay the responsibility for his own mistakes at the door of Providence. The industrial leadership of the country is in dire need of men of broad intelligence and sympathy, men who are not blinded by class interest and who have a due sense of social responsibility.

Changes in our fundamental law can not be indefinitely postponed by a difficult mode of amendment. In the long run the effect is to irritate the public mind and to accentuate such changes. Until the constitution of Ohio was overhauled in 1912, no amendment could be added unless it received a majority of all the votes cast at an election. Every vote that was not cast for an amendment counted against it. Hence, it was next to impossible to amend the constitution. It is true that several amendments were added during the early part of the last decade. The veto power was given the governor, and the double liability of stockholders in certain domestic corporations was withdrawn. But this was done by the Republican and Democratic parties endorsing the amendments and placing the word "Yes" opposite them on the state tickets. As a result of this strategy, large numbers of uninformed and indifferent voters voted for the amendments. It was only on very rare occasions,

however, that the cooperation of the machines of both parties could be secured in this way. The pressure for constitutional tinkering, therefore, increased until sweeping changes were made when the opportunity offered.

On 240 out of the 472 constitutional questions submitted to the voters of the several states in the decade ending with 1908, the vote was less than fifty per cent. of the vote for candidates. In 1910 the vote in Oregon rose to seventy or more per cent. in but 14 out of 32 cases.[37] The heavy handicap of requiring a majority of the total vote cast at an election to adopt an amendment is, therefore, apparent. As a result of this requirement, not a single amendment was added to the constitution of Oregon in the forty-three years ending with 1900.[38] It is possible that both California and Oregon have more recently gone to the other extreme and have made it too easy to amend their constitutions, but a mode of amendment that is practically prohibitory is beyond doubt unsound. Political machinery that compels deliberation and prevents hasty and precipitate action is of the utmost importance to the success of democracy. The formation of public opinion on any question requires time for discussion. The disposition to weigh evidence needs encouragement. Every precaution necessary to both sides of a question having a hearing should be taken. "Tried expedients," "verified conclusions," "traditional beliefs" should not be abandoned without mature deliberation. But when the checks upon the popular will exceed what is necessary to these ends, they not only cease to serve a useful purpose, but become obstructive. Discussion which is stopped at the outset from changing social conditions is useless. When the door to orderly change is closed, the only remaining alternative is revolution.

If the federal constitution were less rigid, both life and property would probably be more secure. A more flexible instrument would not hold things in a vise-like grip, but would permit changes in governmental policy with less social tension. The constitution as it stands leads the courts to make forced interpretations, makes for obstructive delay in the righting of grievances, and pens up the ferment of society until it sometimes threatens the social order. It has discouraged the existence of a party committed to any cause that requires a constitutional amendment. It has helped to make our political contests largely scrambles for offices. So far as principles are concerned, the difference between our leading parties has usually been so slight that it has been very difficult to distinguish between them. In such a humanitarian and democratic age as the present, a constitution that is "based upon the concept that the fundamental private rights of property are anterior to

[37] Ellis Paxson Oberholtzer, *op. cit.*, p. 509.

[38] George H. Haynes, *op. cit.*, p. 24.

government and morally beyond the reach of popular majorities,"[39] and that is at the same time so difficult to amend is out of keeping with the times. So scholarly a man and conservative a thinker as Professor Monroe Smith maintains that

> sooner or later . . . it will be generally realized that the first article in any sincerely intended progressive program must be the amendment of the amending clause of the Federal Constitution.[40]

In Kentucky, not more than two amendments can be submitted at a time; in Arkansas, Kansas and Montana, not more than three at a time. In New Jersey and Pennsylvania, no amendment or amendments can be submitted oftener than once in five years; in Tennessee, not oftener than once in six years, and in Vermont, not oftener than once in ten years. A number of states require a majority of those voting at an election for the adoption of an amendment. In these states, a majority of those voting for and against an amendment does not necessarily suffice.[41] No less than forty amendments that have been added to the constitution of Michigan would have failed to carry if this requirement had been in force.[42] In Wyoming, a majority of the qualified electors, whether voting or not is required. In Pennsylvania, an "amendment must be passed by two successive legislatures before it can be voted on by the people, and the legislature meets only on alternate years."[43] The amendment of the constitution of Illinois is especially difficult. A two thirds vote of each house is necessary to propose an amendment. Not more than one article at a time can be amended, and the same article not oftener than once in four years. Finally, a majority of those voting at an election is required to adopt an amendment.[44] As a result, many reforms that depend upon amending the constitution are practically at a standstill. The advocates of different amendments block each other. The friends of the initiative and the referendum prevent the reform of the general property tax and *vice versa*. Each demands the right of way. In the meantime, the reorganization of the judiciary, the short ballot, the abolition of minority representation in the legislature and home rule for cities are obliged to wait.[45] One is reminded of the celebrated Lecompton constitution which was nearly foisted upon the people of Kansas. In providing for its own amendment, it declared: "But no alteration shall be made to affect the right of property in the ownership of slaves."[46]

One might suppose that the constitution of New York is particularly difficult to amend, judging from the amount of criticism which the highest court of the state has excited in recent years. This, however, is not the case. The constitution has been amended on numerous occasions since its adoption in 1894. New York is suffering from the archaic condition of its judicial mind rather than from the rigidity of its constitution. Professor Walter F. Willcox has noted that the court of appeals, in holding the Workman's Compensation Act unconstitu-

[39] Charles A. Beard, "An Economic Interpretation of the Constitution of the United States," p. 324.

[40] *Op. cit.*, p. 673.

[41] Francis Newton Thorpe, "The Federal and State Constitutions of the United States."

[42] John A. Fairlie, *op. cit.*, p. 149.

[43] William Draper Lewis, *op. cit.*, p. 322.

[44] Francis Newton Thorpe, *op. cit.*

[45] See an interesting series of newspaper articles by Arthur M. Evans, in *The Chicago Record-Herald* during November and December, 1913.

[46] "Debates of Lincoln and Douglas," *op. cit.*, p. 109.

tional, substituted its own assumptions for the facts. In the face of statistical evidence to the contrary, the court held that the statute "does nothing to conserve the health, safety or morals of the employees."[47] Such an attitude of mind is unscientific and until it is corrected no mode of amending the constitution, however facile, can prevent salutary measures from being held up for a time by the courts. "A master of legal history tells us that taught law is tough law. Certainly it is true that our legal thinking and legal teaching are to be blamed more than the courts for the want of sympathy with social legislation which has been so much in evidence in the immediate past. One might almost say that instead of recall of judges, recall of law teachers would be a useful institution. At any rate, what we must insist upon is recall of much of the juristic and judicial thinking of the last century."[48]

Some Pitfalls of Reformers

If property owners now and then stand in their own light, reformers sometimes act with more zeal than sense. The prevailing spirit is too often given to destructive criticism and too little to constructive work. It is too impatient to attain its ends quickly, and relies too little upon the slow-going processes of education. It is too prone to attribute human failure to an unfavorable environment and too little given to laying it at the door of bad heredity. It attaches too much importance to raising wages and too little to stopping leakages, utilizing wastes, and teaching people how to make better use of the resources they already have. It too often imputes improper motives to its opponents. It is occasionally unmindful that there may be honest differences of opinion concerning the wisdom of the remedies which it proposes. It is either too penurious or not sufficiently alive to extravagance in the use of the public money. It has been known to wink at the lawlessness of organized labor while denouncing the lawlessness of capital, or vice versa. It at times needlessly alienates the sympathy of those without whose support it can not succeed. It now and then contents itself with securing the enactment of a statute, forgetful that the laws have no power to enforce themselves. An aroused public opinion is sometimes lulled to sleep by an act of the legislature, and inspectors who do not inspect occasionally give the community a sense of fancied security. Those opposed to a larger measure of social control have been known to withdraw their opposition on the ground that public opinion will not long demand its enforcement. For these and other reasons, the fossilized opponents of reform occasionally render the world a much needed service by calling reformers to account and pointing out their mistakes.

A despotism which secures order, property, and industry, which leaves liberty of religion and of private life unimpaired, and which enables quiet and unobtrusive men to pass through life untroubled and unmolested, will always

[47] *The American Journal of Sociology*, Vol. 18, 1913, pp. 606–612.

[48] Professor Roscoe Pound, *The American Journal of Sociology*, Vol. 18, 1912, p. 339.

appear to many very preferable to a democratic republic which is constantly menacing, disturbing, or plundering them.[49]

These words suggest that the progressive who is true to the interests of mankind is not invariably the foe of property. On the contrary, it occasionally becomes his duty to defend the right of property against its misguided opponents. The abolition of slavery does not justify a crusade against property in general. Human chattels and property in other things do not logically go together. From a social point of view, the two are inconsistent, for the slave has neither the incentive nor the opportunity to become a proprietor. The ownership of one's self is the first prerequisite to the ownership of other things. The total abolition of property rights, or even their drastic curtailment, would promote equality of a certain kind, but it would be equality upon a low level of misery. The lapse of one hundred and twenty-five years has rendered the constitution in some respects unsuited to current needs, but this should not blind us to the fact that the men of substance who brought about its adoption served their day and generation well. They were the real progressives of their time, though some of their work needs revision. Likewise, the opponents of wholesale reductions in railway rates have at times best served the people. Beyond doubt, also, there have been few worse enemies of the ideal of equality than the paper money inflationists who have flourished from time to time. The man who in the midst of turbulence and disorder restores the conditions of orderly industry with a firm hand is the friend not only of property but of labor. But a still better friend of both is he who not only restores order, but who in addition prevents the recurrence of disorder by correcting the conditions out of which it sprang.

The cause of progress commonly enlists the services of the more public-spirited portion of the community. The opponents of the liquor traffic, for example, are undoubtedly less influenced by mercenary considerations than are the liquor interests. It is well to bear in mind, however, that those who take the side of reform at any time are not always such disinterested patriots as one might suppose. Many men engage in politics not for what they can make out of it in questionable ways, but for the love of the game and to gratify the sense of power, and are quite as likely to be found on the side of human rights as on the side of those who have some pecuniary interests to subserve. As any cause gains in prestige, it tends to attract more and more of this class. Moreover, some humanitarian movements are well financed and consequently attract a considerable number of those in whom sordid considerations outweigh everything else. The men and women who espoused the anti-slavery cause at the outset were actuated by high principles, though doubtless some found in the opportunity for notoriety meat for their

[49] Lecky, *op. cit.*, Vol. 1, pp. 259–260.

souls. But when the cause of human freedom became linked with the preservation of the Union and was financed by the government, not only the patriotic and those of high principle enlisted in the public service, but an army of camp followers, cormorants of all kinds and the unscrupulous took advantage of a public calamity to feather their own nests.

"I attribute much of whatever I have accomplished," said a well-known social reformer, "to the fact that I have always been known as a conservative." In like manner, so long as the spirit of progress keeps within the bounds of moderation its future is assured, and neither the opposition of reactionaries nor hostile court decisions can do more than obstruct for a time its way. By the exercise of patience, two amendments have been added to the constitution. If these amendments had failed of adoption, practically the same ends could have been attained in other ways. In the matter of an income tax, the Supreme Court could have been given a chance to reverse itself, or a slightly different law could have been passed which the court might have upheld. More easily still, a substantial part of what was wanted could have been obtained by an excise tax upon corporate and certain other incomes. This device was actually used in passing the Corporation Tax. In regard to the popular election of United States senators, the battle had been largely won in other ways before the constitution was formally amended. If a workingmen's compensation act is held unconstitutional by the highest court of a state, it is possible to amend the state constitution or to pass a law after the fashion of some other state that may pass muster in the courts. If rebuffed by such a decision as in the bake-shop case, it is only necessary to wait and try again when death has recalled enough justices of the Supreme Court to reconstitute its membership. The right, nay more, the duty to criticize the decisions of the courts should, however, never be forgotten. Without criticism it is well-nigh useless to wait with patience. Neither should any one shrink from proposing ideas which may frighten timid souls if reasonably sure of his ground. Many a good suggestion has been rejected only to be accepted later when it is understood. Besides, the saving grain of truth in many an idea that appears crude can only be brought out by discussion, and this can never come about if the idea is kept in a closet and never advanced. The progressive spirit fails of one of its chief missions when it ceases to be educative.

It is sometimes argued that the power of judicial veto ought not to exist in a democratic country. In regard to an absolute veto, the argument is conclusive. Any court decision that for all time stands in the way of what the people want, or that needlessly hampers the popular will, is inconsistent with self-government. But a suspensory veto that can be overcome after due deliberation by amending the constitution is entirely

in keeping with democratic institutions. The right of the people to impose such a limited veto upon their representatives and upon the impulses of a temporary majority is as much a part of their prerogatives as anything else. Moreover, the willingness of the people of any country to adopt a written constitution and to invest in the courts the function of seeing that it is not overridden by the caprice of the moment is one of the surest signs of their capacity to govern themselves. The fact that the judicial veto does not exist in England and other important nations does not prove that it can be safely dispensed with here. Any institution that is so closely interwoven with the warp and woof of a political system as is the power of judicial veto can not be safely thrown overboard at a moment's notice. There is probably no charge that can justly be brought against the courts that can not be met by remedies that leave them the power of a suspensory veto, such as enlightened criticism, an elevation in the character of the bench, and setting the courts free from the letter of the law that killeth and from too abject an adherence to judicial precedent. Especially should impracticable methods of amending our organic law be avoided. The case of our highest court is particularly hopeful. In the words of James Bryce:

> The Supreme Court feels the touch of public opinion. Opinion is stronger in America than anywhere else in the world, and the judges are only men. To yield a little may be prudent, for the tree that can not bend to the blast may be broken. There is, moreover, this ground at least for presuming public opinion to be right, that through it the progressive judgment of the world is expressed. Of course, whenever the law is clear, because the words of the constitution are plain or the cases interpreting them decisive on the point raised, the court must look solely to those words and cases, and can not permit any other considerations to affect its mind. But when the terms of the constitution admit of more than one construction, and when previous decisions have left the true construction so far open that the point in question may be deemed new, is a court to be blamed if it prefers the construction which the bulk of the people deem suited to the needs of the time?[50]

The moment progressives offend good sense, they may expect to be deserted by large numbers of their devotees. Take the movement for the free coinage of silver. There is no doubt that the country acted wisely when it rejected "free silver." But it is equally true that the silver propaganda set back the cause of social and industrial reform for nearly ten years. It accentuated and prolonged the hard times following the panic of 1893 until the country was so intent upon the recovery of prosperity that it was almost indifferent to anything else. Many individuals took advantage of the lack of public vigilance to grab franchises, to enact an excessively high protective tariff, and to organize industrial combinations on a scale that ended in startling the financial world, unsettling business, and in reawakening the sense of public duty in the mass of self-seeking individuals.

[50] "The American Commonwealth," edition of 1910, Vol. 1, p. 274.

One of the most common pitfalls into which many men fall is that of pandering to the popular caprice of the moment. He who says the pleasing thing rather than the truth as he sees it is something less than a reformer. The trend of public opinion is entitled to respectful consideration. An overweening confidence in one's own judgment should be avoided. The mind that is proof against criticism or that is indifferent to the opinions of others has ceased to grow. On the other hand, an earnest attempt should be made to set the majority right if it is wrong. Practically every good cause at the outset has been championed by a small minority. The hanging of witches was once a matter of course. The opponents of slavery for a long time hardly dared speak their minds. The opponent of inflation in many states after the Civil War had no political future. It is only a short time since the higher education of women was held in low esteem. He who sets his own popularity above his sense of public duty lacks the moral courage necessary to right the wrongs of the world. The man of fearless and independent judgment occasionally lives long enough to receive the plaudits of his countrymen, but many men who have done the world the greatest service have never had their praises sung until long after they were dead. The fact that a man holds this or that office may indicate nothing more than that he is a calculating time-server.

(*To be continued.*)

SCIENCE IN NEWSPAPERS

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IT is well known that charlatans and fools sometimes exploit the press for their own purposes. Our journalists are often men of chiefly literary training. They may be able to diagnose a case of megalomania among writers of verse and they may know how to identify a literary pirate. But they are not always prepared to detect scientific frauds or able to discern the fallacies of self-hypnotized persons proclaiming new laws in physics or chemistry. It is no wonder that there exists a general distrust among scientific men for "newspaper science."

This condition is to be regretted. The press is a great educational institution in our age. It is an agent that should be enlisted in the service of science to disseminate knowledge among men. The inefficient service of the American press in this direction in the past is, I believe, a natural result of the momentum of social conditions generally. It is to some extent to be ascribed to the tardiness of our educational institutions in responding to changing social conditions. To be more specific: the journalistic profession is recruited from our high schools and colleges. Few students who have taken up scientific subjects in the curriculum seek, or secure, work on newspapers. Language students, young men and women who have spent their time in studying Greek, Latin, modern languages and literature, are more often given such employment. Suitable courses are not always selected by those who train themselves for newspaper writing. They should be able not only to write good English, but they should also possess a large fund of general knowledge, including the elements of natural science, which now enters into our endeavors almost everywhere.

The above statements express a vague feeling which the present writer has entertained for some time. It has been his desire to investigate the basis for this feeling. When recently an opportunity seemed to offer itself for making some observations on the attitude of the press to science, I decided to make use of it. I collected the reports published by the six dailies of Toronto during the meeting of the Twelfth International Geological Congress, last summer. Copies of nearly all of the six local dailies published from the 7th to the 14th of August were secured, and clippings were made of the reports, articles and items touching on the congress or its members.

The text of these clippings contained about 55,500 words. A rough classification of the contents of this text placed the various paragraphs

under nine catagories, as indicated in the following list, where the approximate number of words and percentage of total space alloted to material of each class is also given.

	Number of Words	Per Cent. of Space
Reports of proceedings	14,420	26
General information about the congress	10,510	19
Reports of social functions	10,310	19
Personal notes	6,720	12
Interviews	5,020	9
Accounts of geological excursions	4,020	7
Reports on individual papers	3,160	6
Editorials	1,240	2
Discussions of scientific questions of popular interest	120	6

About twenty-six per cent. of the space of the text was given to a more or less formal record of the proceedings of the congress, its general sessions, and the sessions of its various sections. A large part of this space was given to the reporting of the addresses of welcome by the government officials and of the replies to these addresses. In the preparation of copy of this kind the reportorial staffs of our large dailies are trained experts and this part of the work was well performed. Not so with the reporting of the professional papers and discussions! Some of the reporters wisely inserted merely the titles of the papers which were read, and the names of the authors.

It is evident that many of these papers were such that reporting even their title seems to have been quite purposeless in a daily paper. The giving of an intelligent statement of their contents by anybody but a specialist would have been impossible. It may have been useless to attempt reporting the papers with such titles as "A physico-chemical contribution to the study of dolomitization"; "On regional granitization"; "Fractional crystallization, the prime factor in the differentiation of rock magmas," and some others. How utterly hopeless it is for the reporter, in journalistic haste, to present to the general reader a comprehensible abstract of a scientific paper, is evident from one report made of a paper on some explorations in South America, by an American geologist. The author is mentioned as attributing the presence of great interior basins to the unequal warping of the earth in the process of elevation. To illustrate this point the reporter then quotes the gentleman as follows:

> It might seem strange to you to live 5,000 miles above the sea, but we think of it as a flat plane. First, there is the plateau sloping at the coast toward the ocean, then the pre-Andean depression and again the depression and again the mountains, which are on the average 70 miles across. The streams that flow west through the Andes, causing international disputes between the Argentine and Chili as to boundaries can probably be attributed to glacial erasion.

In another attempt to report the contents of a paper on "The Influence of Depth on the Character of Metalliferous Deposits," the following obscurities occur:

> "The deepest borings," said the speaker, "had either copper or gold as their objective, but precipitation was most favorable at a depth of 2,000 to 4,000 feet. A point of great interest was the extent of enrichment in regard to depth, but secondary enrichment was limited to a short stretch below the ground water."

In reporting one or two other papers it appears likely that the writers sought and obtained assistance from some competent source, securing much better results.

Only one of the professional papers was made a "feature," by the Toronto press. This was the paper presented to the congress by one of Toronto's own men, on the subject "An Estimate of Post-glacial and Interglacial time in North America." The "write-ups" of this paper demonstrate that the contents of at least some such papers can be profitably reported even in a daily newspaper, if the necessary effort and space be given to the task. Scientific discussion requires an accuracy of expression that can rarely be attained in speedy writing. To give as much space to other papers as to this one was evidently out of the question, and the editorial management certainly made a proper selection in "featuring" this paper. It treated a local subject of general and popular interest.

Under the head "general information about the congress," were classified such paragraphs as could not be placed in any of the other subjects mentioned in the list. These paragraphs include a variety of subjects, from an account of the history of the organization of the first International Geological Congress at Philadelphia in 1876, and an inventory of all the expenses connected with the present meeting, to the length of time taken for a morning nap by some of the attending geologists on Sunday, and the color of the laundry bill received by another visitor. The matter classified under this head consists of items of information secured by the reporters from any chance source about anything connected with the congress. By inquiry from a foreign member, one reporter appears to have learned the significance of the color scheme of the ribbons worn by many of the delegates on the pins bearing their names, and he wrote a neat little item on "How delegates in the Congress know what tongue to use in greeting." Another reporter, probably less obtrusive, wrote a half column under the heading "Politeness a Feature of Congress," evidently basing his observations on what he saw and heard, without making any inquiries. A paragraph which seems to have been based on some interview was headed "Typical Geologists are not Wealthy." Another article, which was probably written off-hand and as a "bluff," dilates on the guess that geologists

know rocks, but are "ignorant of human nature," and that they can neither "bluff" nor "exaggerate." This rather reveals the low ideals of some young men of our day; ideals entertained by a certain class of thoughtless youths in all callings, probably no more frequently among reporters than among others. The best and most effective kind of politics is not the kind that relies on bluffs. While it is likely true that scientists as a class hate sham and exaggeration, it is not to be forgotten that the great recent progress of geology is a direct result of the really effective political talents possessed by some geologists who have held, or who now hold, official positions the world over. Many good geologists are also skillful politicians, not to say that a few have even proved to be better politicians than geologists. As to the discovery that geologists are not a wealthy class, the public was elsewhere treated to interviews with two geologists who were millionaires. Some other millionaires among them seem to have escaped this attention. The space given to the discussion of the private economics of members of the congress must be regarded as a concession, by the knights of the quill, to the vulgar taste of our age, which knows no other measure of a man than his bank account. Everything considered, the presentation to the public of what may be called the general news of the congress was quite complete. Considering that the members of the congress spoke more than twenty languages, while the reporter was limited to two or three, the items of general information gathered were as many and as varied as could be reasonably expected.

One reporter discovered that geologists rarely laugh. "As many as six or eight papers will be read without producing a single flash of wit." To one who attended the sessions and took part in some of the excursions, the fairness of this statement appears questionable, to say the least. While some of the lesser lights of the congress may wisely have avoided any attempt at small wit, there were those who rightly regarded their audiences as consisting of people capable of appreciating humor and who also knew how to indulge without falling flat. In discussing continental movements one of these men said: "It must be a source of great satisfaction to know that the earth in our part is rigid." The reporter evidently took this as a serious statement, for he soon proceeds to make the assertion that "the congress, so far, has not revealed a geological humorist." Evidently the layman is at a disadvantage in this case. He can not always appreciate the background against which the geologists's humor becomes apparent.

In all these three characterizations by the reporters, that the geologists lack humor, wealth and "bluff," there appears a robust survival of an ancient popular attitude to scientists, which is hardly warranted in our time. This attitude is clearly not based on any investigation by the reporters. It is probably the result of high pressure work in filling

space. The editorial managers were apparently disposed to give all space needed for ample information to the public on the congress, and the reporters did their best—and worst.

The reports on the congress contain six formal interviews. Two of the interviewed parties were government officials in charge of geological work in two leading nations of the world. The aim of the interviewer is to procure information that shall prove interesting to the public. These two interviews dealt with the organization and the work of the government geologists in the two countries nearest to the meeting place of the congress. In journalistic work local interest is always to be considered. How the popular interest is always uppermost in the reporter's mind appears in the selection of the subjects of the other interviews. One was a Japanese, interesting because of his nationality. Another was an owner of an anthracite mine. The special topic of this congress was the world's supply of coal. The other two interviews aimed to draw interest by the subjects touched upon—the geology of biblical lands, and the age of the earth expressed in years. The latter subject is twice discussed in the interviews.

From the point of view of the public it is perhaps to be regretted that scientists are averse to being interviewed. They hate to be quoted incorrectly, and they have a great dread for professional criticism. They fear to be suspected of too much appreciating popular recognition. This looks like moral cowardice. Really it comes from the fact that men of science in their work must necessarily ignore popular beliefs and popular recognition of the truths they may discover. But this is no reason why they should be disinclined to make some sacrifice for the education of the public.

All social functions of the congress were reported with fulness and detail. There were the usual descriptions of the gems and laces worn by the leading ladies and there were the customary accounts of felicitous remarks uttered by the men who spoke the toasts. The arrangements made for the entertainment of the visitors on each of these occasions were also adequately described. Here again the demands of local interests were met by the papers. They were performing an every-day duty to their home constituents.

About twelve per cent. of the text may be classified as personal notes on individual members of the congress, light biographical material. Such attentions were naturally given to men in high official positions, men of great renown, or people of unusual and striking accomplishments. The task of selecting the right material was, no doubt, difficult. One prominent foreign delegate was "featured" in this way, because he interests himself in politics and is a leader among the socialists in his home country. In some cases the selection must have depended on the chance of finding the information supplied. No doubt much more

"copy" of this kind might have been secured. Everything considered, this class of copy must have been interesting reading for the public. No one can question its educational value. To the members of the congress themselves it was a help in learning to know each other. In two exceptional cases these sketches may have been unnecessarily embarrassing to the persons concerned, owing to the well-known journalistic tendency to be sensational. The contents of the headlines must have appeared brutal to a Chinese geologist, whom they proclaimed as having arrived in Toronto "in bond."

The many excursions arranged under the auspices of the congress received ample attention, seven per cent. of the text reporting such events. Preference was given to details of general human interest, such as the mode of travel, the personnel of the excursions, and some untoward or amusing incidents. Some reporters appeared disposed to furnish entertainment to the reader at the expense of the excursionists, as when they related in mock-heroic style the vicissitudes of an "armada" of steam launches exposed to a rough sea on an excursion to Scarboro Heights. Though it appears that the press reports might very profitably have presented more of the scientific significance of the things seen on these excursions, any such purpose on the part of the reporter promptly gave way to the dominant instinct of his class to entertain rather than instruct. A visit to the Don Valley, altogether without exciting incidents of any kind, resulted in more serious, though quite brief, references in the papers to the significance of the phenomena noted on the trip.

Editorial writers are usually not interested in the world of science. Nevertheless, some editorial comments on the congress were made in the Toronto papers. These touched on the practical utility of scientific research, and on the relation of society to physical sciences in general. They expressed also a mild defence of these sciences, stating that they are in the popular mind unjustly associated with gross materialism.

The fertile resources of the reporters were shown in their interviewing at least two geologists on a subject of unfailing popular interest—the age of the earth. One of the interviewed gentlemen was quoted as making his estimate 200,000,000 years. Another geologist said it was an unprofitable subject to discuss, and that different people meant different things in speaking of "creation," or of the beginning of the earth. The truth of this latter statement became quite evident in the discussion at one of the sessions of the congress, but this perhaps escaped the attention of the reporters.

The total space given to the reporting of the congress was nearly 3,000 square inches. Of this space about sixty-seven per cent. was text, seventeen per cent. was given to the reproduction of photographs or to other illustrations, and sixteen per cent. was taken up by large head-

lines. There were reproduced the likenesses of fifty-one individuals connected with the congress. Two parties were thus presented to the public four times; seven, twice; and the rest of the fifty-one, once.

In the selection of subjects for illustrations it appears that popular interest was also considered. Gems have an attraction for many, and so have foreigners. The public enjoys what is picturesque. We all like to know the faces of men in high and responsible positions. All this the editors take into consideration.

Some conclusions drawn from this reconnaissance of what the journals of Toronto produced on the meeting of the Twelfth International Geological Congress, may perhaps be mapped in rough outline as below: There is certainly no desire on the part of the press to misrepresent or suppress science or its devotees. The urgent haste imposed on the work of our journalists naturally prevents them from competing in accuracy either with scientists in general or with geologists in particular, whose productions it may take a lifetime to prepare and several years to publish. The same haste sometimes forces editors to use copy which should be consigned to the waste-basket.

The contents of our newspapers always reflect the tastes and the interests of the general public. In the schools attended by those who constitute the reading public to-day, science teaching was defective. Hence, perhaps, the weak public demand for reading on scientific subjects. The looseness of the elective system in our secondary schools is perhaps responsible for the fact that many reporters are sadly ignorant in even the rudiments of science and altogether incapable of appreciating or describing in the most general way the proceedings of such a body of men as met in America on this occasion.

The undesirable result of this shortcoming of the press in its important function as an educator might easily be remedied by cooperation between scientists and journalists on occasions like this meeting. The press should make sure always to be just a trifle ahead, in knowledge as well as in "smartness," of the public it educates.

The elevated position of the savant, intellectually, does not relieve him entirely of general human duties to his fellow men. In the organization of the mechanism of a general congress of scientists of any group, a press committee would be neither a superfluous nor a disgraceful feature. We are all human. A meeting of this kind should be made to hasten the time when the public will demand reliable reports, not only on sports, trade and politics, but also on science.

THE SCIENCE OF HISTORY

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NAPOLEON'S cynical question, "What is history but a fiction agreed upon," suggests a criticism that nervous historians have always felt the need of answering; and much investigation and many speculations have been directed at the adverse critics in the hope of placing the popular science in that favored class where are found such unassailable sciences as chemistry and physics. The discussion of the proposition, "Is history a science?" depends so completely on the definition of the term "science" that one is tempted to take refuge with Mr. Freeman behind the old English equivalent, "knowledge." The failure to recognize the difference between the phenomena of history and those which interest the natural scientists and the disinclination to accept limitations not common to all sciences have always been the stumbling blocks for those theorists who would lead history along the path of objective certainty. History has its limitations and to ignore them is not the way to create a science; but rather we must state exactly what can and can not be known, so that we may escape the will-o'-the-wisp kind of sport, a pastime much favored by the speculative historian. It is, therefore, necessary to recognize the peculiarities of the phenomena, of the problem presented by them, and of the method which can be employed.

For the purposes of this paper the phenomena of history, the activities of feeling, thinking, willing men associated in some kind of a community for mutual protection and benefit, need not be dwelt upon, nor is a discussion of the well-known complexity of such phenomena demanded. Their most conspicuous characteristic is that they all belong to the past. Whereas in other sciences the facts are open immediately to experiment or observation, the events of history are studied mediately through the reports of them, except in so far as actual remains have sporadically reached us. With a liberal interpretation, Mr. Froude is right in saying:

> Historical facts are of two kinds, the veritable outward fact—whatever it was which took place in the order of things—and the account of it, which has been brought down to us by more or less competent persons. The first we must set aside altogether. The eternal register of human action is not open to inspection.

Yet the lack of faith in his witnesses, which is the conspicuous characteristic of the modern historian, is the safeguard against deception. We have passed far beyond the naïve credulity of the medieval

annalist and demand of every historical source proof of the truth within it. We must know which of our sources we can trust and how far we can admit them as witnesses of the fact and what was the fact.

Every period of the past offers difficulties and obscurities peculiar to itself. The sources are either too meager for the precise determination of the event, or as in the modern epoch, so multitudinous that the historian is bewildered by the reports of special commissions and the published and unpublished documents, so that he can only hew a pathway through the wilderness. Further the very personality of the writers makes his task more difficult. If they are ignorant, can he trust them? Are they prejudiced, will he not be deceived? Are they learned, can he give due allowance to the ideas and ideals, social, political and religious, with which they weight their narrative? Thus at the very beginning of the science, in seeking to get at the phenomena, there is endless research to obtain information more or less questionable. For this purpose there has been elaborated a method which is scientific both in spirit and in the results obtained. Yet at this point, however cautious the examination of the sources, there enters an element of doubt into our knowledge of what occurred in the past. On such foundations historians should not seek to build too imposing an edifice. A careful study of the means of construction should be made in order to raise a superstructure whose form and weight have been carefully adjusted to the weakness of the substructure.

The historical problem must, therefore, be stated with a full consciousness of the peculiarities of the phenomena. Now a scientist may attempt to analyze his phenomena and disclose their constituents; he may seek to discover the essential laws of their being; or he may simply trace their growth. This last is unquestionably the point of view of historians. As Dr. Bernheim says:

> History is the science of the evolution of man in his activities as a social being.

The idea of evolution is peculiarly an historical one; that events are not isolated, but fit together as cause and effect of an ever-changing whole, is the assumption which underlies all historical knowledge, without which no progress can be made; every movement of the world's history conditions the next, although the finite mind is unable to follow the line of connection at all times. The fact that history traces an evolution separates its problem definitely from that of sociology, with which there is such danger of confusion, for the phenomena of the two sciences are almost the same. Sociology is the science of social statics, history of the social dynamics; the one studies the average of masses, the other individual facts or events; sociology would explain the mechanics of society, history the development; the former seeks to discover the general laws underlying the particular phenomena, while the latter is contented to trace the life history of the particular event. It

is that in which history is interested, the individual fact with all the differences, marking it as something unique in the past. Sociology studies the same phenomena, but draws from present and past in her search for conditions of like kind, disregarding individual variations, and therefore hopes—so far without much success—to find types and even discover laws. What sociology with its different point of view and method may hope to acomplish is not a part of the historical problem.

The demand has been made of the science, however, that it disclose the laws of social dynamics. The futility of such an attempt will be more fully seen after the discussion of the method of reasoning in history; but at the present moment it is sufficient to note that to discover a law by observation—the only method capable of being employed by the historian—there is need of finding a type or typical development, the law of which will be the law of all similar phenomena. It is not to be denied that there have been in the past certain recurrences of similar forms which some philosophers have eagerly asserted to be typical regularities of social development from which laws may be learned. On account of the complexity of the phenomena, in which these similar elements are closely interwoven with variants, and because the observations at best are unreliable and can never be corrected by repeated trial, a complete knowledge of the conditions or of the occurrence is not possessed by the historian and there is, therefore, no secure basis for an induction. Besides the collection of a number of similar facts from various periods is not the usual method of the historian in whose eyes events are individual in character, never combining the same conditions, never following the same course. These very differences are those which he seeks. Even here he must acknowledge himself baffled in his search for the sufficient cause of these variations which mark them unique. He finds their beginnings and traces their development, but, as far as his knowledge goes, it is conceivable that quite another succession of events might have been enacted, and then he would have zealously shown how it too fitted into the evolution past and present and interdigitated so accurately with the other phenomena. From the observation of an isolated event, dissimilar to all others, no law can be formulated.

From another point of view attempts have been made to discover the laws controlling historical development. The world's history is continuous; each nation, each period forms but a part of the grand whole; on this broader field can we find laws of historical evolution. We historians stand in a very different relation to our phenomena than does the natural scientist; in the twisting and squirmings of the microcosm we read our own destiny. Never can we get outside of the course of the evolution of which we are ourselves a part, and view it as something entirely foreign to our wills. An objective criterion of the truth, although not wholly lacking, is still by no means so perfect as that offered the natural scientists. But a still greater difficulty confronts

us; there is no whole and completed development in the world's history; the beginning and the end are unknown; the origin is shrouded in darkness; before the future there hangs the veil of Mayo; we can observe the pupa or cocoon, but not the caterpillar and moth. Under such conditions every explanation must be subjective in character.

Leaving then to one side the search for laws of social dynamics, the historian contents himself with disclosing the causal relations of the successive movements in the evolution of human society, and this is the sole aim of history; but even here the science is subject to important limitations for the use of experiment is impossible, so that the method must be that of observation. At best many disadvantages confront the observer, which are not encountered by the experimenter, so that his results form a very insecure basis for induction, unless, as in other sciences, his observations can be often repeated and the human senses aided by sensitive instruments. But repetition and the use of instruments are not for the historian, who works over the observations of the untrained minds of the past. In seeking the cause or causes of any phenomenon the natural scientist views it as a type of a large class; and even in the case where causation is determined by a single experiment, there always exist numerous phenomena of the same kind or else the particular phenomenon offers itself to the possible repetition of the observation, so that the assurance of the opportunity of repeating the test case plays an important part in the induction. The scientist abstracts from the occurrence all individual variations and finds the cause of the typical phenomenon, which is generalized in thought so as to cover all individuals of like kind. Thus are obtained causal relations, which have objective truth. Such a method of abstraction is inapplicable in history, for, as we have already seen, from the point of view of the historian each phenomenon is exceptional and can not be classified to find types, and also the same conditions and events never recur.

In the search for causal relations how far is it possible to make use of the canons of inductive logic? On account of the reasons stated above it is impossible to find two events which agree or disagree in all respects except one. Therefore the canons of agreement and difference are of no assistance in historical research. The impracticability of these canons in history has always been acknowledged, and yet the literature of history as well as of sociology and economics is filled with errors arising from their unscientific use.

Of the inductive canons there remain those of residue and of concomitant variations, neither of which is a very safe criterion of causal relations and both of which can to a limited extent be employed by the historian. When there are general propositions proved by other sciences, such as psychology, sociology and economics, which will establish the needed partial causation, the canon of residue can be used. The value of such reasoning will depend on the reliability of the general

propositions and on the historical possibility of their being true when applied to the conditions of a society of the past. Again the certainty of the result will depend on the assurance that the historian has discovered all the conditions, and this will always remain an open question. The reverse process, so popular with sociologists and psychologists, is also of some service. By the collection of the data of individual acts and striking an average, the personal volitional element can be approximately eliminated, and the residue over and above the probable conduct reveals a partial cause of the activities of the masses. Besides the meager data which the past affords and the impossibility of sending elaborate questionnaires to past generations, both of which facts hinder the use of this method, the results reached by such means show only the general tendency, the probable action, and not the particular acts and motives which form such a prominent feature of history.

The true method of history would seem to be the canon of concomitant variations; but unfortunately there is no invariable measure, as in the physical sciences, by which variations can be mathematically determined. All elements of social life vary continually. If we select one as a measure for all, we may be using that which is most variable and certainly one of the causes of variations in other elements of society. In fact a social yard-stick is wanting. In the study of primitive society this canon has been employed successfully because of the large number of similar phenomena, both past and present, but it fails to satisfy the needs of the historian of a civilized people.

By this hasty review of the canons of inductive reasoning, it is seen that only two, and these the least desirable, can be employed by the historian, and then with very material limitations. History is not a science of pure induction and never can be. The facts of history could never be joined into causal relations by induction alone. If there were no other means, history would remain chronology.

How then can causal relations be established by the historian? The answer is: "By deductive and teleological reasoning, for the most part by the latter."

The past illustrates the operation of the laws which have been established by the social sciences. The method of deduction can be employed in cases where individual volition can be eliminated, where causes psychological or economic affect large masses of individuals, bringing about important historical changes. In tracing economic development and social psychic life this method establishes causes which satisfy the mind and a large mass of historical knowledge is thus removed from the charge of uncertainty.

As a rule, however, the historian's view of the past is teleological. We are obliged to pass from effect to cause just as we do when reviewing our own lives. Knowing the end reached by human society at any period, we trace back the events which have been the means of bringing

about this existing state. Every event is a means to an end; it is purposive. Either some seemingly unimportant event has widened into numerous ends or the many events have united to produce a given end. According to this point of view, the historian eliminates factors which seemingly have no purposive relation to the result. These effects are employed to explain causes rather than that causes are shown blindly to produce effects. As Mr. Freeman constantly insisted:

> You can not understand the present without a knowledge of the past, nor can you understand the past without a knowledge of the present.

The present is the purposed end and is to be explained by the means which brought it into being. The past is the means and can only be understood in the light of the end which it is to bring about. In the natural sciences there is no such view of phenomena as this predominating. Chemical affinities are not regarded as means to bring about ends, but as forces which produce effects blindly and necessarily and will do so on all occasions; there is nothing arbitrary about the individual result; but in history we are dealing with human society, where movement is caused by volition, by "individual will acts." As far as man can perceive, history is made, not entirely, of course, but very materially by purposive ideas and not wholly by the blind action of chemical-physical forces.

Instinctively one asks whether this teleological view corresponds with the actual state of society, and the answer must be negative. Studying society carefully before any great historical movement, it would seem that out of it any number of events might emerge. There are possibilities of many great movements from the conditions present; and, after we know the outcome, we have a case of double sixes appearing when the dice are thrown. We may argue from the double sixes back to the cause, if we will; but from the causes ascertained by us, double twos might have resulted as well. The solution of a problem in probabilities is the final result of any science which studies human dynamics.

We have hit upon the weakness in any argument to prove history a science comparable to the natural sciences. The scientist believes in the universal reign of causality and fixes as the goal of his search the establishment of causal relations between his phenomena which have truth in reality, that is, objective truth. The belief in the persistency of such causal relations assures him that there lurks no subjective element in his result. Now the phenomena of developing society are of such a nature that any association of causal relation between them will generally contain an element of uncertainty, because there is lacking an objective criterion; and hence the mind hesitates to assume that a knowledge of the complete cause is ascertained or that the effect must have followed the causes which can be determined. That all which happens in society is the result of effective causes can not be denied by

one believing in the uniformity of nature, but it is denied that the mind is able to peer through the darkness of the past and see the hidden workings of forces in the soul of humanity.

Historians have been loath to acknowledge frankly this limitation, and instead have promulgated various theories to account for human phenomena without even a tacit assumption of ignorance. They would prove that history has been caused by universal forces, cognizable by man, and that man is an automaton, tossed hither and thither as the forces of the cosmos have acted upon him. To this end social evolution has often been likened to the life of a living organism and the resemblances are sufficiently remarkable. It is influenced by its environment; it has its separate parts with their functions; blood vessels and nerves are not lacking; and the cells are the individuals of which society is composed. The simile is a very happy one, but it remains a simile.

Misled by the resemblances, historians have often sought to carry over into their field of inquiry the methods of the biologists, hoping thus to silence forever the denunciations of inexactness and to establish causation in their science in the same way as it is done by the investigations of the life of the lower animals and plants. According to this theory, the cosmic causes of the varying phenomena among people are to be sought in their physical environment. In the ultimate analysis, natural variations must be derived from the same source, for "we can not regard any nation as an active agent in differentiating itself. Only the surrounding circumstances can have any effect in such a direction." Yet as far as the historian is concerned these national varieties are the most important facts in his knowledge and the ultimate explanation of many events in the world's history. As Mr. Symonds says,

> Nothing is known for certain about the emergence from primitive barbarism of the great races, or about the determination of national characteristics. Analogues may be adduced from the material world; but the mysteries of organized vitality remain impenetrable. What made the Jew a Jew, the Greek a Greek, is as unexplained as what daily causes the germs of an oak and of an ash to produce different trees.

History has to accept this dissimilarity of peoples with all its results, for an unproved hypothesis should not form the foundation of its method.

Closely connected with the above is the still unsolved problem of heredity. Is not heredity one of the great causes of variation among men and hence an important factor in the production of historical movement? This question, to which I shall return later, must be answered in the affirmative by the historian, to whom the differences between individuals and between nations are conspicuous characteristics of his phenomena, and as far as his information reaches are due to the accidents of birth as well as to environment.

Furthermore, the biological historian slights the great internal fact which separates the social organism from all others and makes it a unicum, to the study of which the biological laws are not applicable, namely, the social psychic life which is such a large factor in the evolution of man. It is a characteristic of highly organized society to wean itself from that dependence on the physical environment which is such an important element in the lives of animals and savages. Therefore a community of human beings can not be treated as an unconscious organism, wholly conditioned by its material surroundings which create blind forces determining its development. Organic needs do not make psychic factors subservient to them, rather the opposite is the case. Mind exercises a control over the material needs and directs the exertions of society. The vague use of the terms of biological science, natural and sexual selection, when employed in speaking of the social evolution, seem more metaphorical than real; for on this higher plane of life the two laws play but a very subordinate part, both being subservient to intelligent choice without the necessary result of the elimination of the weak and "unfitted." The mental life of man, which takes the forms of religion, science, art, and mechanical inventions, creates an environment of a wholly unbiological character and becomes by accumulation a tradition, a psychic environment, or rather it is the soul of the organism; for the individual men, the cells of the organism, change but little from generation to generation and do not alter their physiological character, nor do they, as ages pass, acquire any great increase of power, mental or spiritual. The evolution, in fact, during the historical period is transferred from the individuals of society to the social psychic environment of the community, which undergoes changes from age to age, as the activities of men of successive generations add their portion to history. Thus no physical and physiological analysis of this peculiar organism can satisfy the requirements of our science. After the study of the economic struggles and the institutions of any period, which also have a psychic side, there remains for the historian the tracing of the mental and spiritual life in its various and complicated forms.

Certain theorists claim that we have in this psychic environment a means of determining the sufficient causes of historical events. The physical and psychical environment together reveal the sufficient reason for the acts of any generation. There can be no question of arbitrary self-determination: for, born into certain conditions, man acts as the forces physical and spiritual compel him. Given the territory, the national characteristics, the institutions, the social psychic environment and we have history a connected whole with cause and effect verified as in the natural sciences. The activities of individuals in relation to these great forces are like the waves on the surface of the deep

ocean. A man may raise himself above the level a moment but sinks back, having affected the whole so little that the historian can eliminate the free-will acts of individuals and treat only the life history of generic man. "The new direction of historical investigation," says Professor Lamprecht, the leader of this movement, "has first brought pure causality into history, because it seeks to prove the causal coherence of the generic life of man, and does not confine itself to the deeds of eminent men." It is not to be denied that such an historical hypothesis has value, but it is one-sided and, as far as our knowledge goes, is but half a truth.

It has been already shown that from the nature of the subject matter, history is concerned with the particular rather than the general. It is the personal act amidst the almost never changing activities of the masses that interests us. This personal act, however, is an unknown quantity in every generation. The generic man is but an average of the community, within which there are numerous variations, just as is found by the naturalist among the individuals of any species of animals. These variations are not due wholly to the physical and psychical environment, but come partly from the accidents of birth, which the historian can not trace to their first cause. The forces which are to produce historical movements are not existent except in the souls of these individuals of which the average of any given community would take no account. The social psychic environment will affect and develop these variants in different ways, and the sum total of these variations will give rise to historical phenomena which would not be perceived in the external causes acting on the community.

After the fact we can know the effect, but why there was that particular effect instead of many possible others escapes our search. Within the zone where past tradition meets present variations, we can not follow the intricate working of forces. In the last analysis, therefore, an important cause of historical phenomena lies in the soul of the individual and must be sought in his variations from the multitude, a mystery locked in the secret chambers of the germ cell, in his relation to the past, which constantly changes with the person, in his motives of action, which can not be massed with those of his fellows. Infinite knowledge may follow amidst the complex mingling of will and will, desire and desire, of the millions of individuals the line of cause and effect, but man with human intelligence stands in the presence of any generation as before the entrance of a dark cavern into whose innermost recesses his eyes can not penetrate.

The higher the civilization the greater these variations from the average. Savages are much more similar psychically than the more civilized, just as plants conform to the type closer in the natural state

than in the cultivated. It is this close approximation to a type that gives the biologist encouragement in his investigation of the life of the lower organisms. As soon as he is compelled to acknowledge the entrance into his problem of individual volition, his hope of discovering laws or causal relations similar to those found by the chemist or physicist is limited just as is the case of the historian. In civilized nations the variations among men are multitudinous. Amidst such great dissimilarities can we talk of a generic man? Is every one compounded of two parts, a personal and generic?

There are times when the contrary theory seems justifiable, when one is willing to declare with Emerson:

> Every true man is a cause, a country, an age: requires infinite space and number and time fully to accomplish his thought—and posterity seems to follow his steps as a procession. A man Cæsar is born and for ages after we have a Roman Empire. Christ is born and millions of minds so grow and cleave to his genius, that he is confounded with the possible of man. An institution is the lengthened shadow of one man, as the Reformation of Luther—Methodism of Wesley. All history resolves itself very easily into the biography of a few stout and earnest persons.

To outward seeming eminent men are the result of fortuitous variation and are similar to the "sports" of the biologist, since the connection between them and their origin remains even more obscure than slighter variations; and these "sports" of history are unquestionably the direct cause of changes in the community. Their peculiarities are preserved, permeate the whole mass of individuals and become in time part of the social tradition. The simile of the deep ocean of social psychic life and the waves of individual activities does not present the correct picture, for the waves subside and leave the depth of the ocean the same, while the influence of the individual does not disappear but lives on after his death, increasing the extent and variety of that environment out of which he came.

The limitations of the science of history are very real. The phenomena are hidden in the past from personal observation, are the most complex of all sciences, are unique in character and apparently the result of the will acts of individual men, whose motives are derived from mingled hereditary and environmental influences. At times the historian can by induction or deduction discover a sufficient cause of the phenomena, but more frequently he is obliged to acknowledge the impossibility of unravelling the tangled thread of causal relations amidst the purposive and arbitrary acts of millions of individuals. As historians must seek for the social forces in the souls of the individuals composing society, historical cause will always remain in the circle of probability and thus differ from the causes established by scientists in the physical and biological world.

THE PRACTICAL NECESSITY OF SCHOOL CLINICS

By E. H. LEWINSKI-CORWIN, Ph.D.

EFFICIENCY was defined by one of our great American engineers as "the relation between *what is* and *what ought to be*." Judging by this standard and agreeing on the premise that one hundred per cent. efficiency in medical school inspection means a complete discovery of all of the ailments and defects of the children followed by a prompt, rigorous and effective alleviation and cure of them, so far as they can be alleviated or cured, we must admit, in the light of established facts, that we have not only failed to reach the uppermost notch of efficiency, but that we are quite a good distance away from it. I shall not attempt to reproduce here the tables of statistics showing the number of defects noted in the schools of this and other countries and the corresponding statistics of treatments and results of treatments. They are in a general way known to all of us. In New York City in 1911, for instance, 166,368 children were found to be needing treatment, of whom 65,150—or not fully 40 per cent.—were reported as treated. We don't know how many of the defects noted were actually remedied, as there is, of course, a difference between reported treatment and actual cure. A single visit to a dispensary is considered as treatment, and there is no law whereby the Health Department of the city can enforce further action, even if in its opinion the treatment is inadequate. Nor is such a law desirable. We are evidently not accomplishing fully what we have set out to do. There is a serious gap between our aim and its fulfilment.

Efficiency depends almost wholly on the application of certain broad general principles. When our work proves to be falling short of efficiency we must either change our methods of procedure or revise the underlying principles governing them, or both. One of the principles of medical inspection of school children is to point out defects, leaving it to those most interested in the welfare of the children to have them attended to and treated—a perfectly reasonable expectation which, however, like many other social theories and assumptions, is, unfortunately, not being borne out by actual facts.

Many parents are ignorant, many negligent and indifferent, many are overworked and indigent. Campaigns of education and social reform will undoubtedly decrease the numbers of the ignorant and the indigent, but this is a slow process. If our faith in school medical inspection is justifiable and if we really mean to decrease the appallingly large amount of illness and physical discomforts among school children and conserve their health, thus promoting well-being and sound education, we must

recognize that our underlying principles must be altered and actual conditions met more satisfactorily than by mere observation and noticing of defects.

Medical inspection of school children is in its infancy. Before a satisfactory method will be worked out many experiments must be tried out and many careful inquiries made. The present fragmentary study was undertaken on behalf of the public health, hospital and budget committee of the New York Academy of Medicine to demonstrate a method of testing the value of certain elements entering into the effectiveness of our medical school work, in order to determine whether school clinics are a practical necessity. Matters pertaining to the health of the school children of the City of New York are confided to the care of a dual authority—that of the Department of Education and the Department of Health. The sanitary care of schools, the instruction in physical training and personal hygiene, the segregation of backward and mentally defective children, are entrusted to the Department of Education; all the other elements of the medical school inspection are under the control of the Department of Health.

There are instances where the work of the two departments overlaps; there are instances where the two departments collide. There are opportunities for mutual dissatisfaction and irritation, which at times engender ill-feeling and refusal to cooperate on the part of individuals. We shall eventually come to the point, it seems to me, when we shall have to decide on some definite policy of procedure, which will eliminate any possibility of friction. We should like, therefore, to know precisely to what extent the full and complete cooperation of the teaching staff with the medical corps is to be counted on as a factor in bringing the efficiency of our school medical work to the highest possible pitch. Then, we have a great many dispensaries in the City of New York, varying in size and efficiency. The knowledge of the extent to which the proximity of a large and well-equipped dispensary affects our problem is also essential before a definite policy is adopted. Thirdly, we harbor within our city limits population composed of various races, of various degrees of intelligence and education and differing in economic status. We should like to know to what extent these factors enter into our problem.

Recognizing the importance of these elements, we have selected four schools in the Borough of Manhattan: One on the lower east side, in a section whose population is composed almost entirely of Russian, Austrian and other Jews, and where the cooperation of the school authorities with the health officers is known to be excellent. Then, another school amidst a mixed population—foreign to a great extent, where the interest of the principal in the work of the health department's officials was known to be slight. A third school was selected, again in a Jewish quarter, but in another section of the city, near a large and efficient dis-

pensary, and a fourth school in a representative well-to-do district of the city. It was impossible for us to go over the cards for all the children of those four schools, so we decided to take as many cards as we could get for one class of each grade of the schools in question, endeavoring in this way to bring into the study children of all ages in each school. In all we have examined 1,452 records. From these closed records for the first term of 1912–1913[1] we have tabulated the number of children suffering from physical defects, but have not included cases of contagious diseases or communicable diseases of the eye and skin, as they are being treated in schools, so that our inquiry referred only to cases of defective vision, defective hearing; defective teeth, primary and permanent; defective nasal breathing; enlarged tonsils; defective nutrition; cardiac, nervous and pulmonary diseases; and orthopedic defects.

There were 1,617 cases of these defects alone noted for the 1,452 children whose records were examined. Bad teeth constituted two thirds of the defects. While the per cent. of all the defective children found among those investigated in the four schools, exclusive of bad teeth, was 41, it varied from school to school. It was 40 per cent. on the lower east side, 54 per cent. on the east side in the neighborhood of 30th Street; 21 per cent. in the well-to-do uptown district, and 50 per cent. on the upper east side near 103d Street. Of all the defects, bad teeth were most poorly attended to. In the school in the foreign district of the city where cooperation of the school with the medical corps was very good, 90 per cent. of the cases of defective permanent teeth were treated, but none of the 147 children with carious milk teeth received any treatment. In the school where cooperation was poor, 28 per cent. of cases with defective permanent teeth were treated and no primary teeth defects were reported remedied. In the school in the well-to-do section of the city, 56 per cent. of cases of bad permanent teeth were treated and 17 per cent. of bad primary teeth. For the school near the dispensary, 35 per cent. of bad permanent teeth is reported as treated, and out of the 239 cases of primary bad teeth only 1 is reported as having been treated. As to other defects the cooperating school reported 94 per cent. of children with defects receiving treatment as against 65 per cent. for the school whose attitude was antagonistic to the Department of Health. The well-to-do section school reported 80 per cent. of its defective children under treatment, and the school near the dispensary reported 86 per cent. under treatment. If the teeth defects be counted in, then the per cent. of treatments for all the defects, other than communicable eye and skin diseases, will respectively be: 47 per cent., 32 per cent., 54 per cent. and 41 per cent. As to individual defects, the following table shows the per cent. of treatment in the case of four chief classes of defects:

[1] In the case of School No. 171, the cards for the year 1911–12 were used, because the records for the first term of 1912–13 were unsatisfactory

TABLE I

	Defective Vision, Per Cent.	Defective Nasal Breathing, Per Cent.	Enlarged Tonsils, Per Cent.	Teeth.	
				Primary, Per Cent.	Permanent, Per Cent.
School A: lower East Side, good co-operation	75	100	95	—	90
School B: neighborhood of 30th Street and 2d Avenue—bad co-operation	55	63	70	—	28
School C: uptown well-to-do district	90	91	80	17	56
School D: upper East Side near a dispensary	85	95	82	.4	35

The numbers of other defects are too small to be of use for comparative purposes. The table shows that eye troubles receive treatment in 55 to 90 per cent. of cases and that adenoids and tonsils are attended to in from 63 to 100 per cent. of cases. Evidently special stress, at times too much stress, is being laid on this class of defects. It is instructive to note that at times with full cooperation of the school authorities it is possible to attain 100 per cent. of treatments in certain classes of ailments. Teeth present the poorest showing as to amount of attention and treatment given, even in the well-to-do section of the city.

As has been already mentioned, reported treatment and actual results should be regarded as two distinct statistical categories. Under existing conditions, figures of treatments should be taken with great reservation as an indication of efficiency of results attained by medical inspection of school children. The school health records indicate the number of cases which in the opinion of the school doctor were cured or which improved under the reported treatment. Tabulating these statistics, I find as far as the cases are reported that, exclusive of teeth, out of 482 cases treated only 204, or 42.3 per cent., have been cured, and 96 cases, or 20 per cent. have improved. The remaining 37 per cent. are not recorded as cured or improved. Granting that among the defective children under treatment there were a number of incurable cases, and allowing for clerical errors of omission, 38 or 30 or even 25 per cent. of non-cures and non-improvements in school children is a very high percentage. Aside from mere figures, experience shows that a large percentage of those reported treated do not improve, a condition which calls for serious consideration and which is due in a large measure to slipshod therapeutics in dispensaries as well as by some private physicians, especially in the poorer sections of the city.

Contrary to the prevailing notion of the abuse of dispensaries by patients able to afford a physician's fee, the statistics for the four schools as to source of treatment, show that 235 of the 482 cases treated for defects other than teeth went to consult physicians and only 228 made use of dispensaries. The remaining 19 are not accounted for.

TABLE II

INDICATING PLACE OF TREATMENT, OF DEFECTS OTHER THAN TEETH, AS REPORTED ON SCHOOL CARDS.

School	Total Number of Cases Treated	Treated by Physicians	Treated in Dispensaries
School A: lower East Side	104	47	56
School B: neighborhood of 30th St. and 2d Ave.	88	41	45
School C: uptown well-to-do district	94	54	31
School D: upper East Side	196	93	96
Totals	482	235	228

TABLE III

INDICATING PLACE OF TREATMENT OF DEFECTIVE TEETH, AS REPORTED ON SCHOOL CARDS.

School	Total Number of Cases Treated	Treated by Dentists	Treated in Dispensaries
School A: lower East Side	90	75	8
School B: neighborhood of 30th St. and 2d Ave.	24	11	13
School C: uptown well-to-do district	75	48	3
School D: upper East Side	39	22	16
Totals	228	156	40

The same to a much greater degree is true of dental work. 156 private dentists were consulted as against 40 in the clinics. It is a remarkable showing, considering that three of the four schools are in the poor sections of the city. The conditions can be ascribed to the following three causes: (1) parents do not want to pauperize their children in taking them to free dispensaries; (2) people have not strong faith in the effectiveness of dispensary treatment; and (3) the hours of the dispensaries are in many instances not suited to the convenience of the children and, furthermore, going to a dispensary, under the present conditions of overcrowding, entails long hours of waiting.

All of the figures quoted in this inquiry must, of course, be taken with many grains of salt. The element of negligence and error on the part of the physicians and nurses making out the records must be taken into consideration. Then, the four schools selected out of a total of 513 public schools of the city of New York may not reflect prevailing conditions adequately. These considerations lead one to insist on the importance of a similar study on a large and comprehensive scale where the element of error would be minimized and the conditions in a majority of schools in all parts of the greater city analyzed. Meanwhile, the present fragmentary study tends to indicate: (first) that although the difference in the economic and educational status of the various classes of the population is a factor to be reckoned with in adopting measures leading to efficiency of medical inspection of school children, yet the average

percentage of defects treated in children of parents in better circumstances and of an average higher level of education is not materially different, if at times not smaller, than in children of the poorer sections of the city: in this connection it must be noted that the per cent. of children with defects other than teeth was much lower in the well-to-do section than in any of the three other sections; (second) that full and harmonious cooperation between the teaching staff and the medical corps is an element of extreme import in the efficacy of the work. In some instances, especially in cases of defects with reference to which a great deal of popular education has been undertaken, it is evidently possible to attain one hundred per cent. of treatments when the cooperation of the principal and teachers is genuine and wholehearted; (third) that the proximity to the school of a well-equipped and efficient dispensary tends to increase the usefulness and efficiency of the work of the medical school inspectors; (fourth) that in the case of children's ailments, parents, even of the poorer classes, resort in fifty per cent. of cases to the services of private physicians; (fifth) that over thirty per cent. of reported treatments of school children by private physicians and dispensaries do not result in cure or improvement; and (sixth) that teeth are of all the largest and most neglected class of children's defects.

Should a comprehensive study on the lines suggested in this paper bear out the above cited conclusions a thorough revision of the underlying theory and methods of our medical school inspection should be undertaken and serious attention given to the institution and organization of school clinics where efficient, competent and prompt work would be done.

School clinics are being tried in various parts of the country and abroad. In New York City we have dental, nose and throat, and contagious eye diseases clinics for children, maintained by the Department of Health. The number of these clinics is small and their location is not planned to meet the peculiar needs of certain sections. The only therapeutic work done in schools of New York City is by nurses who treat minor skin and eye troubles like scabies, ringworm, favus, impetigo and conjunctivitis. This measure alone has decreased the number of school exclusions from 57,665 children in 1903 to 3,361 in 1911, but what is more important than mere school attendance, it has effected positive cure in thousands of cases.

It is my personal opinion and belief that school clinics, if adopted on a broader scale, should be established if not in every school, then in schools centrally located, so that children from other schools in the vicinity could easily reach them. The clinic districts should not be made too large, that the evils of overcrowding may be avoided and the children not subjected to waiting long and many hours. The treatment in school clinics for those who need it and are unable for one reason or another to

secure the services of conscientious practitioners should be given not as a gratuity, but as a legitimate part of the functions of the school, just as a physical training or baths or recreation.

There will, no doubt, be opposition to them at first. We attempted once to enucleate tonsils in schools and we had street riots in the Italian section of the city. There will be other sources of opposition. Every new experiment or departure from established routine is bound to invite opposition, but as the clinics demonstrate their usefulness and efficiency, the opposition to them will gradually wane.

A number of sources has been suggested to secure the means necessary for the maintenance and operation of such clinics: budgetary provision by the municipality, special assessments, voluntary per capita contributions of a couple of cents weekly by the parents of the children, and, finally, the establishment of branches in school buildings by dispensaries caring to reach out. Each of these suggestions has its merits, but the last two may prove impractical. A system of collecting small contributions is cumbersome and costly, and establishing of children's clinics in schools by dispensaries is not very probable; furthermore, the extension of the field of the gratuitous service of the physician is impractical and unjust. Physicians must be paid for their work and paid adequately. If the establishment of school clinics proves to be a public need then, not one class or classes, but the community as a whole must defray the expense of their maintenance and operation.

THE LABORATORY OF COMPARATIVE PATHOLOGY OF THE ZOOLOGICAL SOCIETY OF PHILADELPHIA

By R. W. SHUFELDT, M.D.

WASHINGTON, D. C.

IN various publications recently I have pointed out the fact as to how little is being done in the way of describing the anatomy of the existing Vertebrata of our fauna. One animal after another is now being exterminated with a rapidity never before equalled in the history of man, neither has there ever been a time in that history when so little was done to preserve detailed accounts, properly illustrated, of the comparative morphology of the species so doomed.

This state of things is not entirely confined to our own country by any means, for the same neglect is but too apparent elsewhere. Faunæ are being exterminated and material recklessly wasted at zoological gardens, laboratories and other places to an extent that is most deplorable. Comparative anatomists of the next century will be fully justified in saying what they please of such criminal neglect as this, when they come to realize the extent to which those of the present one ignored their opportunities in this field of scientific research, and allowed so many animals to die out without leaving the shadow of a record describing their structure.

We are doing much better with respect to the study of the causes of death in those ferine forms which die in captivity, for the activity along such lines is very marked and more or less universal. Not only are the diseases of the vertebrates below man being studied in numerous and fully equipped institutions in this country and abroad, but, through various scientific methods, comparative pathology, including that of man and the domesticated animals, is being investigated, studied and utilized in a manner far more extensive than has ever been the case in the history of our race. Such investigations include the parasites of the Vertebrata, a field of research which has received so much attention during recent years at the hands of Dr. F. E. Beddard, prosector of the Zoological Society of London, in the Old World, and Dr. Charles Wardell Stiles, of the Bureau of Animal Industry of this country.

Recently I have been in communication with Dr. Herbert Fox on this subject, and he has kindly placed at my disposal a set of photographs illustrating the building and the work rooms of the Laboratory of Comparative Pathology of the Zoological Society of Philadelphia, of which institution he is now the pathologist in charge. Dr. Fox has also

FIG. 1. EXTERIOR OF THE LABORATORY BUILDING OF COMPARATIVE PATHOLOGY OF THE ZOOLOGICAL SOCIETY OF PHILADELPHIA.

sent me some excellent photographs of pathological specimens prepared at his laboratory and obtained from animals which have died at the Philadelphia Zoological Garden. These are very instructive, indeed; but, much as I regret the fact, they can not well be used in the present connection.

It was in 1901 that pathological work upon the animals that died at the Zoo was inaugurated, and this at the instance of Dr. Charles B. Penrose, of Philadelphia, who had as advisers in the matter the late Dr. Leonard Pearson, of the Pennsylvania Veterinary Department, and Dr. M. P. Ravenel, of the State Stock Sanitary Board.

The first pathologist to the garden was Dr. C. Y. White, assistant director of the William Pepper Laboratory of Clinical Medicine, in which laboratory the post mortems were done.

We learn from the Thirty-first Annual Report of the Board of Directors of the Zoological Society (1903) that no fewer that seventy-six different species of mammals had there been examined with the view of ascertaining the cause of their death, and the result of the autopsies recorded (pp. 20–25). A large number of these mammals were various species of monkeys, apes and their allies (Primates), and the great majority of these succumbed to general tuberculosis.

Besides this much-dreaded malady, these animals suffered from twenty-five other diseases of which they were the victims; this does not

FIG. 2. GENERAL LABORATORY WORK-ROOM.

include the parasites observed, nor one bird—a cow bird—in which case molluscum contagiosum proved fatal. These examinations were made during the period from November, 1901, to March 1, 1903. Numerous other animals also died during this time of which no record was kept and no examination made; these were principally birds and indigenous species of mammals, reptiles and other forms. They died chiefly from the injuries and disturbances incident to their capture and captivity, most often shortly after reception, and, as a general thing, no special use was ever made of them.

Dr. Penrose reported that

> In ten of the animals examined no cause of death was discovered, though careful investigation of all the organs was made, as well as bacteriological examination of the blood. Change in food, water, temperature and general environment, may cause the death of wild animals in captivity, without producing gross or apparent lesions of any of the structures of the body. It is probable that in some cases the animal dies of a toxæmia due to improper food, though we have been unable to determine the existence of this condition at autopsy. The *post mortem* changes have usually rendered the bacteriological examination very unsatisfactory.

These reports of Drs. Penrose and White, continuing until 1906, are of great interest and importance, but altogether too extensive even for summarization here.

In 1905 a building was selected upon the grounds of the garden and, at some expense, remodeled for a pathological laboratory, Dr.

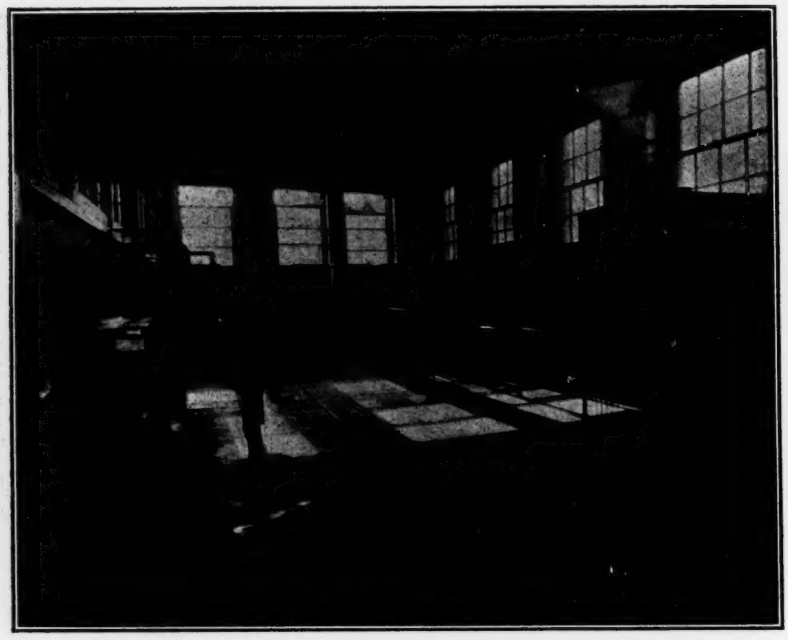


FIG. 3. ONE OF THE QUARANTINE ROOMS.

Fox taking charge of this the following year (Fig. 1). As the operations of this department became more extensive, it was realized that the labor of no one man could properly compass it; therefore, in 1910, Dr. Fred D. Weidman, who at the time was assistant in the department of pathology at the University of Pennsylvania, received the appointment of assistant pathologist, and the following year a second floor was put upon the building to accommodate the museum specimens and for additional work-room.

From about this time on, the principal part of the report of the society was given over to that of the pathological laboratory, a most gratifying indication of the value of the work performed there. As evidence of this we find that the thirty-ninth annual report of the board of directors of the society (1911) prints forty-seven small octavo pages, and of these Dr. Fox's report of the laboratory occupies from pages 15 to 40 inclusive.

Far-reaching in its importance, this report contains most valuable data, which can not fail to be of use, not only to keepers of gardens and menageries, but to the human pathologist and the breeder of domestic animals. The report goes to show that no fewer than 325 animals were examined, of which number 93 were mammals. There is an excellent report on "Tuberculin Reaction in Monkeys" containing much of practical value, while what Dr. Weidman gives on "Parasites" is not only quite extensive, but presented in great detail. A valuable special report

FIG. 4. AUTOPSY ROOM.

on "Bird Diphtheria" follows, with others on "Recurrent Ophthalmia," and one made by Drs. E. A. Schumann and Fox on "Leucocyte Counts."

All these are in evidence of the marked activity of this very efficient laboratory, and the character of the contributions we may expect from it in the future. Autopsies are performed on all the animals which die in the gardens, with the exception of the small reptiles. Dr. Fox says:

> The data concerning the animal during life is sent to the laboratory from the office on a special card form and the pathological findings are put upon this card. It is then used as a zoological index card and the diagnoses are cross indexed in a pathological system. Routine and special pathological and bacteriological methods are used as in the usual laboratory systems. The data obtained from these diagnoses is used in the hygiene of the garden and for scientific record.
>
> Included in the laboratory's work is the testing of animals suspected of having tuberculosis, a test made by subcutaneous injection of tuberculin. All monkeys received by the garden are observed for several days, and a record made of their daily 3 P.M. temperature. They are then tested, and if negative to this test are passed to the general monkey collection. If the test be doubtful, they are either held in quarantine or put on exhibition in isolated cages. If the test be positive they are killed. In order to avoid the carrying of tubercle bacilli on the hair they are washed in phenol solution upon arriving in and leaving the laboratory. Because of the frequent occurrence of proventricular worms in the parrots, the laboratory also examines the excrement of all new arrivals before they are put on exhibition.

This laboratory consists of an equipment of a two-floored building. We find on the first floor the general laboratory workroom (Fig. 2),

FIG. 5. MUSEUM AND LIBRARY (SECOND FLOOR).

fitted up for special experiments and investigations. On the same floor there are two quarantine rooms, one of which is here shown in Fig. 3, wherein are seen the cages in which are kept the animals under observation, or those presenting pathological conditions requiring their isolation. Beyond these we have the autopsy room, fitted out with all the modern appliances for performing post mortems.

In the case of three of these rooms, the walls are coated with hard paint, and center-drains are found in their concrete floors for the purpose of frequent flushing. One of the quarantine cages measures 27 × 24 × 20 inches and a larger one 29 × 36 × 30 inches, the top in any case being five feet from the floor. These comfortable quarters are of galvanized iron and fitted with a door which can not be opened by the animal.

Passing to the second floor of this building, we find it given over to a single room of considerable size, measuring thirty feet by sixty-nine. It is lighted overhead by a large, central skylight, while windows are only found in the north and east walls, the south and west ones being unpierced in any way to admit light. In this room is kept the collection of pathological specimens, some of which are from human subjects for the purposes of comparison. Many drawings, charts and photographs are upon the walls, while tables and desks are placed in convenient corners for the use of those doing clerical or laboratory desk work.

For the purpose of destroying the animal remains after autopsies and dissections, there is in the building a direct incinerating plant—a most important adjunct to an institution of this kind.

The personnel of this laboratory is not large, being at present confined to the pathologist, assistant pathologist, technical assistant and a diener.

Should it come to pass at any time later on that the pathological work now being prosecuted in this very efficient department of the Philadelphia garden be supplemented by similar researches upon normal anatomy, for the purpose of which plenty of material is constantly there at hand, it will become necessary to increase the number on the present staff by adding to it a duly qualified prosector, zoological artist, photographer, and one or two additional assistants. It is very much to be hoped that this will be brought about in the near future.

THE PROGRESS OF SCIENCE

THE AMERICAN MUSEUM OF NATURAL HISTORY

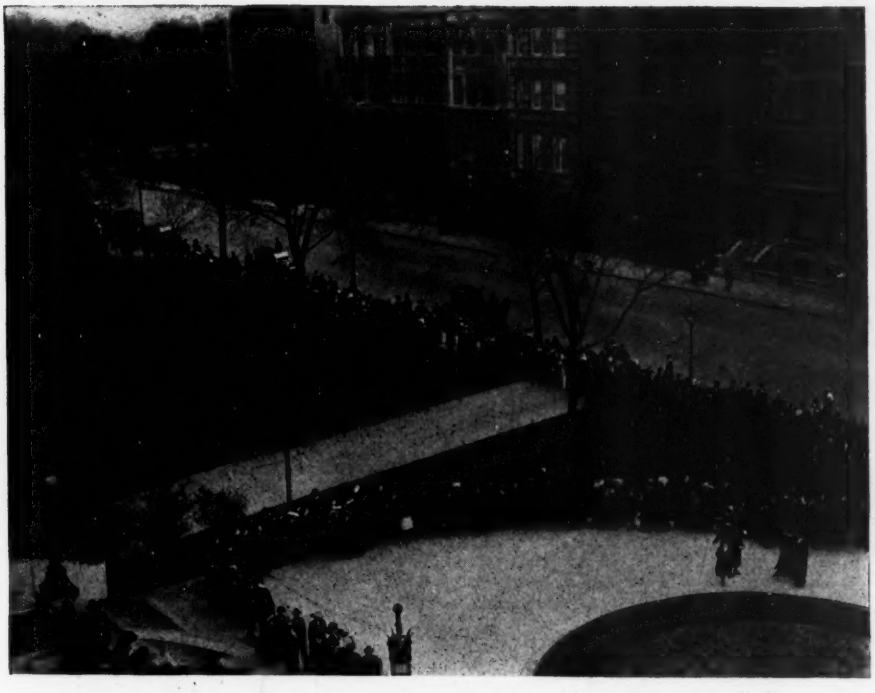
THE extraordinary development of universities in the United States is paralleled by the growth of its museums. In Washington, New York, Chicago and Pittsburgh, four museums of natural history have in a comparatively brief period taken their places among the leading institutions of the world, and in many other cities there are important and growing museums. Many of these museums, like the universities, are interesting demonstrations of the possible achievements of a democracy. On the one hand, they are supported in almost equal measure by taxation and by private gifts, on the other hand, they are devoted not primarily to the preservation of stuffed animals, but to education, research and public service.

The forty-fifth annual report of the American Museum of Natural History in New York City illustrates these remarks. The city has provided land and buildings worth many million dollars and approved a plan of development of unexampled magnitude. The city also provided last year $200,000 for maintenance. Then for exploration, research and the increase of the collections about $250,000 accrued from private endowment and gifts. The annual gifts are about equal in amount from the trustees and from members and friends, who number some 3,500.

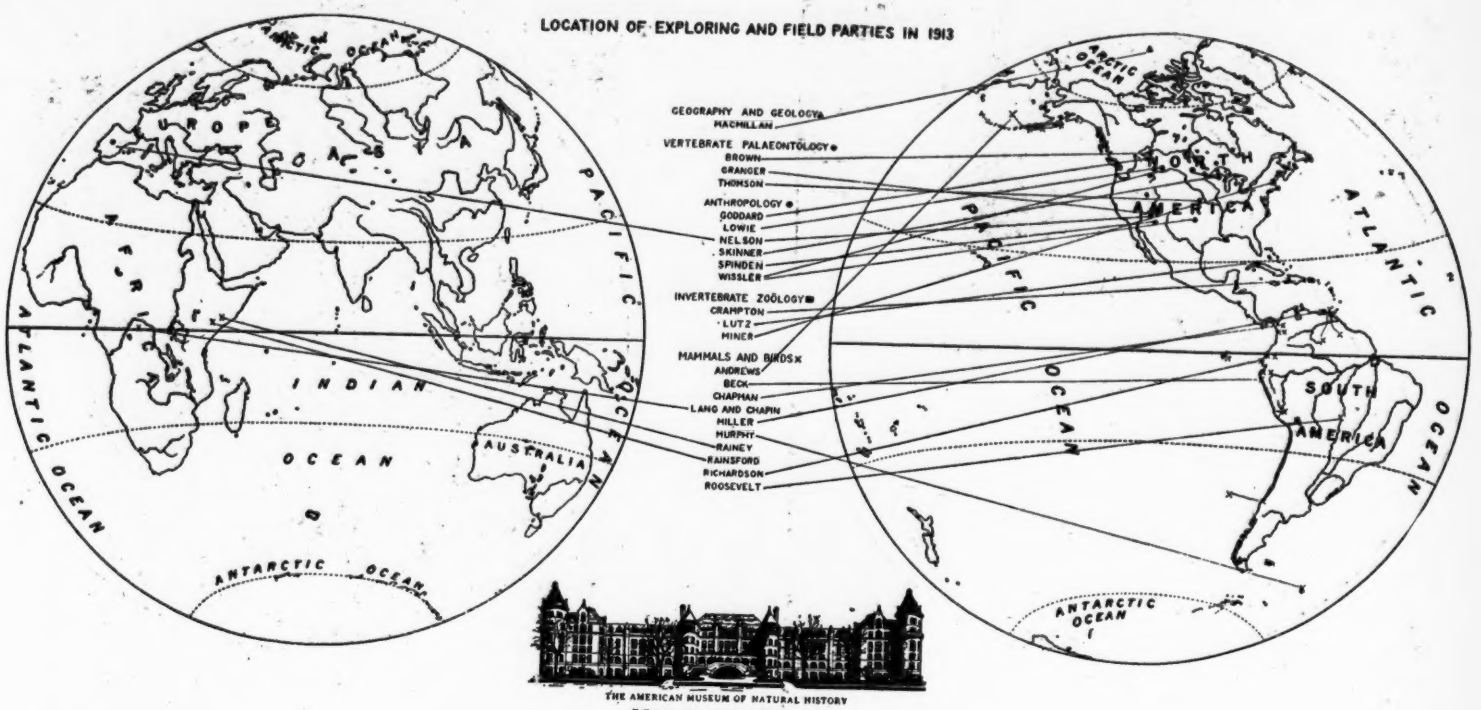
The illustrations here reproduced show the museum and its approaches, though it should not be assumed that such crowds enter the museum every day in the year. The total attendance in 1913 was 866,633, of whom 138,375 were primarily present for lectures and scientific meetings. Part of the attendance in the galleries was due to the flower exhibition of the Horticultural Society and other temporary exhibits, which Dr. Lucas, the director, holds do not result in any real profit to a museum. We should suppose, however, that while such exhibits and the large number of lectures and scientific meetings may not greatly increase interest in the natural history collections, they enlarge the functions of a museum in a desirable manner.

This holds still more for the expeditions and research work. As in the university the professor earns his salary by teaching but is expected to advance knowledge, so in the museum the curator must care for the display of the exhibits but he should also be engaged in scientific research. So long as society provides no way of paying directly for the results of investigations having no immediate commercial value, these must be undertaken by universities and scientific institutions. This should be regarded as part of their function, but in any case it is justified by the fact that the professor or curator will do the work of teaching or caring for collections better if he is encouraged to engage in research and publication, and under these circumstances better men can be secured for the positions.

Though the museum has been unfortunate in losing two of its most distinguished investigators, Professor Boas of Columbia University in anthropology and Professor Wheeler of Harvard University in invertebrate zoology, it produces each year an important series of contributions to scientific knowledge. Last year the sum of $25,000 was spent on publications, partly technical researches, of which Dr. P. G. Elliot's "A Review of the Primates" is the most noteworthy, and partly on popular publications, including the excellent "Museum Journal."



VISITORS ENTERING THE AMERICAN MUSEUM OF NATURAL HISTORY.



THE AMERICAN MUSEUM OF NATURAL HISTORY

MAP OF THE WORLD.

The report of the president, Dr. Osborn, reviews the general progress of the work of the museum, noting the establishment of a contributory pension system, according to which the employee contributes to the fund three per cent. of his salary and the trustees provide an equal amount. Among installations, the collection of bronzes made in China by Dr. Laufer is especially noted. Gifts include the Mason archeological collection from Tennessee by the late Mr. J. P. Morgan, the Angelo Heilprin Exploring Fund, established by Mr. and Mrs. Paul J. Sachs, and numerous specimens from individuals and institutions.

The museum, however, must depend for its most valuable accessions on its own expeditions. The number and range of these expeditions in 1913 are shown on the chart. The expedition to Crocker Land, under Mr. McMillan, suffered from the stranding of the *Diana*, but has proceeded to the Arctic regions. Expeditions to the north in search of bowhead whales and to the south to secure the nearly extinct sea elephant were not successful, but other material was obtained including motion pictures of the life on the seal islands. The paleontological and ethnological expeditions in the west from which important collections and researches have resulted were continued. In South America Mr. Chapman and others have made ornithological surveys and collections, and the present expedition of Mr. Roosevelt is under the auspices of the museum. Africa has been explored by Messrs. Lang, Chapin, Rainsford and Rainey. Dr. Osborn, the president, has visited the French prehistoric caverns. Such expeditions not only increase in the most desirable way the collections of a museum, but also contribute in large measure to the advancement of science.

THE MARVELS OF SCIENCE

IT would perhaps be worth while to issue a number of THE POPULAR SCIENCE MONTHLY consisting entirely of articles sent in by those who in Bishop Berkeley's phrase are "undebauched by learning." At first sight it might seem disquieting that there are so many people in the United States without the slightest training or appreciation of scientific methods who would like to publish their views on electricity, gravity, the ice age and similar topics, or have them endowed by the Carnegie Institution. But we may in fact regard it as a not altogether unsatisfactory symptom of universal education in a democracy, and of growing interest in science. The pseudo-science often exhibited in our daily papers and legislative halls will surely be eliminated by a comparatively small increase in education and the control of public sentiment by those who know, and we may then look to a notable advance in scientific research through the rewards and opportunities which a discriminating public would be able to bestow.

While it might be unfair to print some of the contributions sent in, it may not be amiss to quote two paragraphs which have just now been brought to our attention. The first is from a speech in the House of Representatives by Mr. Hobson of Alabama, which is being widely circulated under the congressional franking privilege. He said:

> The last word of science, after exact research in all the domains, is that alcohol is a poison. It has been found to be a hydrocarbon of the formula C_2H_6O, that is produced by the process of fermentation, and is the toxin or liquid excretion or waste product of the yeast or ferment germ. According to the universal law of biology that the toxin of one form of life is a poison to all forms of life of a higher alcohol, the toxin of the low yeast germ, is a protoplasmic poison to all life, whether plant, animal or man, and to all the living tissues and organs.
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> After long continued drinking, even though temperate, the microscope shows that the white blood corpuscles, with the serum which contains their vegetable food continually sucked up by the dehydrating toxin, become carnivorous, and begin to feed upon the tissues and organs, like disease germs. The favorite tissue food of

the degenerate corpuscles are the tender cells of latest development. In the human being the latest development is the brain. The microscope shows the degenerate corpuscles, with the goods upon them, down in their bodies the gray matter of the brain. This accounts for the tremendous mortality among heavy drinkers and for the degeneracy that will be referred to later.

The second quotation, the head-lines and editorial from the April publications of a Sunday newspaper syndicate, is as follows:

WHEN THE WORLD'S BACK BROKE

By James Oliver Curwood

Illustrated by

Charles Livingston Bull

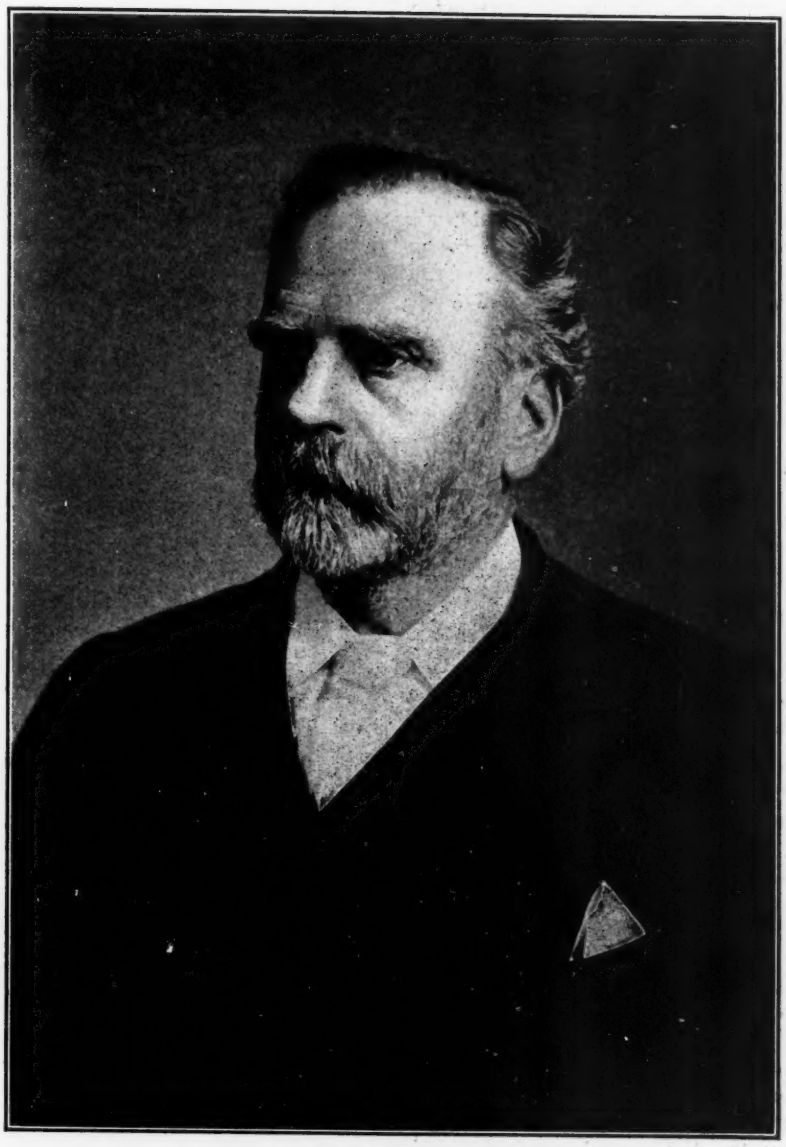
EDITOR'S NOTE.—Mr. Curwood is the first writer to tell in fiction the dramatic story of that day, thousands of years ago, when in the space of what was probably no more than a few minutes the earth tilted twenty-three and a half degrees on its axis, transforming what was then a tropical world into the blackness of a night which lasted for unnumbered centuries, and out of which came what are known as the North Polar regions of to-day. In that one "first night" of a life that had known only perpetual day all living creatures perished; but entombed in their caskets of ice and frozen earth many of them have come down to us fifty or a hundred thousand years later, so completely preserved that the flesh of mastodons recently discovered was eaten by dogs and men. In fact, Mr. Curwood helped uncover a mastodon at Fort Migley and ate of the flesh.

QUARANTINE OF HAWAIIAN FRUIT

THE office of information of the Department of Agriculture has sent out a notice in regard to the stringent regulations which have been adopted to guard against danger from the melon fly and the Mediterranean fruit fly. Any one who attempts after May 1, to bring into the United States certain Hawaiian fruits, nuts and vegetables will face a penalty of $500 fine or imprisonment for a year or both. A new order issued by the Department of Agriculture provides this punishment for attempts to violate the quarantine declared in 1912, under the plants quarantine act, against Hawaiian products which might introduce into the United States two dangerous pests, the melon fly and the Mediterranean fruit fly. Under the new regulations importations of bananas and pineapples are permitted under stringent conditions of inspection and certification. Practically all other fruits and such vegetables as tomatoes, squashes, green peppers and string beans are absolutely excluded. Circulars are to be distributed on all incoming steamships warning passengers of the quarantine and the reason for it.

Hitherto the United States has fortunately been free from both the melon fly and the Mediterranean fruit fly. The latter in particular has proved a source of great loss, practically putting an end to the fruit industry wherever it has obtained a good foothold. The Bermuda peach crop, for instance, is now a thing of the past. It is believed to have originated on the west coast of Africa, its name being due to the great damage it did after it had been carried to the Mediterranean. It also spread to Bermuda, South Africa, Australia and New Zealand, whence it was carried in ships' cargoes to Hawaii. In all probability the fly would be in California to-day if it were not for the fact that no fruit is grown in the immediate vicinity of San Francisco. The great danger is that some traveler may unknowingly bring with him as a curiosity pest-infected fruit, nuts or vegetables and introduce them into a region favorable for the fly's spread.

Commercially the quarantine will not seriously interfere with Hawaiian industries. Bananas and pineapples, the only fruits which are grown in the island in commercial quantities, do not, as a rule, carry the infection. When properly inspected and packed in accordance with the department's regulations, they will, therefore, be allowed admission. Other fruits, such as alligator pears, Chinese ink berries,



THE LATE SIR JOHN MURRAY,
the distinguished Scottish oceanographer.

figs, guavas, papayas, etc., are far more dangerous. They have, however, little commercial importance. If they are taken on board at all, they must either be consumed or thrown overboard before the ship reaches the United States.

SCIENTIFIC ITEMS

WE record with regret the deaths of Dr. Edward Singleton Holden, astronomer and librarian of the United States Naval Academy, formerly director of the Lick Observatory; of Mr. George Westinghouse, the distinguished inventor and engineer; of Dr. Alexander F. Chamberlain, professor of anthropology at Clark University; of Adolph Francis Alphonse Bandelier, an authority on South American archeology, lecturer in Columbia University, and of Dr. John Henry Poynting, professor of physics at Birmingham University.

A PORTRAIT of Sir William Ramsay, painted by Mr. Mark Milbanke, has been presented to University College, London, by former colleagues and past students. Professor J. Norman Collie made the address. A replica of the portrait has been presented to Lady Ramsay.

THE former students of Dr. J. McKeen Cattell, professor of psychology in Columbia University, at a dinner held in New York on April 8, presented him, in celebration of his completion of twenty-five years as professor of psychology, with a "Festschrift" in the form of reviews of his researches and of the work in psychology to which they have led. On April 6, 7 and 8, there was held at Columbia University a Conference on Individual Psychology by former students of the department of psychology, at which thirty papers were presented.

THE Rockefeller Institute for Medical Research, New York, announces that it has received from Mr. John D. Rockefeller an additional endowment of $1,000,000 for the purpose of organizing a department for the study of animal diseases. A gift of $50,000 has also been received from Mr. James J. Hill, for the study of hog cholera.

FOLLOWING the disastrous fire at Wellesley College the General Education Board has promised to give $750,000 to the college on condition that the balance of the $2,000,000 restoration and endowment fund is completed by January 1, 1915.

MR. ANDREW CARNEGIE has given $100,000 to the New York Zoological Society to provide a pension fund for the New York Zoological Park and the Aquarium. The scientific staff and the employees will contribute annually 2 per cent. of their salaries, and any sum that may be lacking will be made up by the Zoological Society.

AS has already been noted in *Science*, the American Chemical Society held its spring meeting at Cincinnati, Ohio, during the week of April 6. Each of the sections had a full and important program. At the general session on the first day, after addresses of welcome by the mayor of the city and the president of the University of Cincinnati, and a reply by the president of the society, Professor Theodore W. Richards, the following papers were announced: Arthur L. Day, "The Chemical Problems of an Active Volcano"; L. J. Henderson, "The Chemical Fitness of the World for Life"; W. D. Bancroft, "Flame Reactions"; Irving Langmuir, "Chemical Reactions at Low Pressures."